ADMINISTRATIVE CONTROL AND EXECUTIVE ACTION

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Administrative Control and Executive Action

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PREFACE

The Book. The purpose of this book of over seventy readings is to provide a balanced, concise, and varied source for the study of the many-sided aspects of control. It should appeal to those who must exercise control because of their responsibilities, and to those who must study and teach control because of its fundamental importance in administration.

The subject matter of the large number of executive and management development programs and continuing education courses offered to employees in business, government, and the professions, not only *should* but *must* include the study and discussion of elements of control because control is an essential ingredient of successful management at all levels. In effect, the proper exercise of control often is the key to managerial effectiveness and growth.

College and university preparation for administration—whether in business or in the professions—must effect a thorough understanding of the function of control, of its varied applications and principles, and of the skills and techniques needed to control the activities of an enterprise.

This book of readings is designed to serve the above areas by grouping carefully selected readings in the theory and application of control. Section A of the book introduces various definitions of control and continues by discussing the background of control, especially its important position in the emerging science of administration. Sections B, C, and D offer a variety of applications, including the newer tools of applied mathematics. Finally, Section E presents a challenging and stimulating view of the future of administration, especially as it relates to control matters.

This book is adapted for use as a major textual device in a course in control. It also is an invaluable supplementary device for a course built around lectures, discussions, cases, or problems which deal with specific as

well as general areas of administration and control. Attention is called to chapters which deal with the place in control matters of accounting and reporting, cost analysis, budgeting, break-even analysis, and other selected management tools. Some chapters discuss various planning and decision-making processes relating to both short- and long-run considerations of profitability and capital investment. Other chapters deal with the application of control to over-all administration, finance, production, marketing, personnel administration, and more specific areas within these classifications.

A book of readings provides the opportunity to present a variety of authors and, therefore, a cross-section of varied approaches. In this book, an article may combine several topics which are presumably dealt with in other articles or in separate chapters.

In quite a few instances, portions of articles, some footnotes, and an occasional illustration have been omitted from the articles presented in this book in an attempt to minimize duplications and remove material irrelevant to the specific intent of this book. In no case was any attempt made to vary the position taken by the authors or to change the primary intent of their articles.

Control. The increasing complexity and growth of modern organizations and the vastly improved methods of communication and reporting have forced management to pay greater attention to the administrative process. Control has shared in this development. Control follows planning, but just how closely it follows and how much it includes depends on how broadly or minutely the administrative process is subdivided. It occurs at all levels and in all types of activity, whether creative or routine, and whether human or mechanical.

The word control when used negatively may imply purposeful restraint or restriction. When used positively, control includes the helpful aspects of review and guidance with strong overtones of supervisory powers. From an administrative point of view the minimum definition includes *the review of actual progress by comparison with the plan and observation of the variance or deviation.* An expansion of the definition adds the "doing something" about the pre-emergence, correction, or disposition of the variance or deviation.

Control must be adapted to the specific administrative process of which it is a part. Thus, it is necessary in this book to discuss administration in a general sense in order to fit control into the proper perspective. Administration is presented in its broadest dimension as it applies to any economic, political, or social organization. After control has been identified as a segment of administration, it is more closely scrutinized from varying viewpoints through the use of general and specific applications. The specific applications are by and large from the business field.

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Special acknowledgment and thanks is due to Thomas N. Horton and Niels C. Buessem, Editors, Charles E. Merrill Books, Inc., without whose invaluable assistance and editorial guidance the book could not have been published. The cooperation of the various primary domestic and foreign sources of the materials included in this book are also gratefully acknowledged.

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PART ONE

ADMINISTRATIVE CONTROL

Section A:

THE ELEMENTS OF CONTROL

Debate as to whether administration or management is an "art" or a "science" will undoubtedly go on endlessly; in part, but not altogether, this is due to a lack of common agreement on the differences between the two. Journals, such as *Management Science* and the *Administrative Science Quarterly*, by their very titles imply that a sizeable group regards "science" as a proper designation.

Kenneth E. Boulding prepared a review of the first two volumes of the *Administrative Science Quarterly*, and that portion of it is included in the readings in which he gives his views on administration as a science. Theories are an essential ingredient of growth in any science, and articles by Edward H. Litchfield, Herbert A. Simon, and Robert V. Presthus propose theories of administration and organizational behavior. Administration or management is dealt with in these articles as applicable in a broad but realistic sense to any organization, without any special regard for the nature or purpose of the organization. The implication of this should not be overlooked, for in one sense at least it means that a person skilled in administration can readily shift from one organization to another without automatically incurring the penalty of failure. It should not be assumed, therefore, that the articles just mentioned are limited to the business

enterprise: this can also be said of a fair number of other articles included in this book of readings.

Perhaps those who prefer to regard administration as an "art" may find some indirect support in the article by Robert M. Hutchins in which he candidly describes portions of thirty-three years of administering non-profit organizations including some overtones of how he would do it now if he had to do it over again, based on experience and hindsight.

Regardless of the classification favored by the reader, there is little doubt but that administration or management, of business especially, has tended to evolve as a clearly defined profession in the United States because of the extensive use of the corporate form of organization which encourages a marked separation of ownership and management. The growth in size and respect of collegiate schools of business reinforces the concept of business administration as a distinct professional area.

The remainder of the articles in this section tacitly assume, for the most part at least, that it is business which is being discussed either directly or indirectly. The growing importance of business management is stressed by Herrymon Maurer in "The Age of the Manager." The importance of management in general and its important function of decision-making are thoroughly discussed and outlined in two separate articles by Robert Tannenbaum. Robert L. Katz also gives an indication of the scope of business management by reviewing the several skills which an effective administrator should possess. Richard M. Cyert, Herbert A. Simon, and Donald B. Trow are co-authors of "An Observation of a Business Decision." R. K. Gaumnitz and O. H. Brownlee are co-authors of "Mathematics for Decision Makers" which opens a new array of management aids made possible by the application of mathematics which, in turn, is made feasible by new hardware such as the electronic computer. Other articles relating to mathematical applications to specific problems appear in other sections of this book of readings.

Control, another term which is subject to a variety of definitions, is one of the extremely important functions of management which follows closely after decision-making. Control may be viewed as playing the relatively passive

role of reporting the progress made in carrying out a decision once it is made, usually by comparing the plan which implemented the decision with the actual accomplishment in order that deviations or exceptions can be noted and appraised. Control can also be assumed to play an active role by adding to the foregoing that control should also include the purposeful activities of assuring compliance with the plan. Arnold F. Emch emphatically takes the latter position in "Control Means Action." Articles by Alex W. Rathe and James L. Peirce continue in much the same vein by discussing control as a tool for carrying out plans incorporating, as they do, organizational principles and plans which they regard as important for such purpose.

An article by Bradford Cadmus on "Operational Auditing" discusses a relatively new use or extension of internal auditing into management areas. Internal auditing, in turn, is described in the "Statement of Responsibilities of the Internal Auditor" as issued by The Institute of Internal Auditors. Internal control is defined in an excerpt from a pamphlet issued some years ago by the American Institute of Certified Public Accountants. The staff position of controller is ideally and realistically described by an excerpt from a recent publication of the Controllers Institute of America. When finished with this section, it will be apparent to the reader that the word control has a central meaning, to be sure, but also a number of interesting facets.

I

WHAT IS CONTROL?

1. THE PLANNING AND CONTROL CONCEPT

James L. Peirce*

Mr. James L. Peirce uses his definition of planning and control to differentiate between the proper authorities and responsibilities of the president and other operating heads of a business corporation and those of the controller. The budgetary process is regarded as an essential element in both planning and control.

A discussion of the planning and control idea might be started by saying that it is synonymous with management itself. Certainly no business can exist without some form of this twin concept, and it might perhaps be demonstrated that success in business is proportionate to the astuteness of its planning and the skill with which it is controlled.

DEFINITION OF PLANNING

It may be useful at the outset to define "planning" (as the word is understood in the concept we are discussing) and to place it in relation to the control function. Planning, of course, is carried on during every hour of the business day, and sometimes during many other hours besides.

* From *The Controller,* XXII, 9 (1954), 403-6, 422, 424-25. Reprinted by permission of *The Controller.*

It may exist with or without control—that is, with or without disciplined efforts to follow the plan or to explain deviations from it. On the other hand, control cannot exist without planning, and therefore the planning must be designed to fit the specifications of control.

In the modern sense of an integrated planning and control system, then, planning refers to the construction of an operating program, comprehensive enough to cover all phases of operations, and detailed enough that specific attention may be given to its fulfillment in controllable segments. It may therefore be reiterated that the planning process must be conducted in direct relation to the needs of control.

DEFINITION OF CONTROL

An examination of this word "control" shows that, like many another word in the English language, it has a number of meanings. It is absolutely necessary to have a clear understanding of its definition in the specialized sense in which it will be used herein.

Perhaps the easiest approach to this shade of meaning is to mention some of the things that the word "control" in this usage does not include. It does not signify the kind of control over a business enjoyed by a majority shareholder. It does not refer to any part of the control centered in a board of directors or a president. It does not include line authority for making or carrying out policy or operating decisions.

What then is "control" in the sense to be used here? It is defined as the presence in a business of that force which guides it to a predetermined objective by means of predetermined policies and decisions. Every business executive can identify this control force in his company. It operates quite apart from the mass of operating decisions and instructions constantly emanating from the line organization. It does not steer the course, but it informs operating management at once of any significant deviation from it. It does not take action, but it frequently impels action by turning a spotlight on the pertinent facts.

ORGANIZATION ASPECTS

The practice of this variety of control may be referred to as controllership. When delegated, it is exercised by an executive properly called a controller, although he may not actually carry that title. His title may be, for example, vice president and treasurer and his controllership assignment intermingled with financial and other administrative duties. Nevertheless, regardless of title, because he performs the controllership function, he will be referred to here as the controller.

Planning is the primary duty of the president, assisted by all line and staff executives. The control function is exercised by the same group, but may be centered functionally in the controller. The objective of controllership is to assist all levels of management in controlling to the plan. It never issues orders, but it coordinates the machinery of planning, records and reveals the facts and makes plain to those in charge what they must do to achieve the prescribed aim.

THE CONTROL FORMULA

The control process, like all effective modes of management, rests on a simple principle. It may be stated as a three-part formula:

The first component is the adoption of a plan.

The second is reporting actual performance as compared with the plan.

The third is making decisions and taking action.

This pattern is repeated as many times as there are units of responsible supervision in the company, and the whole is assembled as a grand plan which directs the company's operations and controls its course. As time goes on, experience sometimes dictates alterations in the plan. Action taken as a result of reporting performance against plan reaches forward to new and better plans.

It should be evident that the three phases of the formula are operating concurrently—that a management following this system will be constantly planning, reporting and taking action. The important thing to note is that the decisions reached and the actions taken will be directly related to a master plan. They will not be spasmodic nor will they be consummated without adequate reference to the fundamental objectives of the business. No decision or action will be taken which is out of harmony with actions in other departments of the business, because all are governed by a universal plan.

THE ADOPTION OF THE PLAN

The initial step, the adoption of a plan, is perhaps the most difficult. Even after the habit of planning has become ingrained, it is not easy to induce a group of executives to set aside pressing matters and think into the problematical future.

First, consider the form in which the planning is to be stated. The common denominator, of course, is money. All planning must ultimately be translated into dollar figures, which is the language in which business operates. The ultimate form of the programming therefore is, typically, a planned profit-and-loss statement for a forthcoming period of, say, 12

months, supported in detail by sales budgets or forecasts, expense budgets and so on, and also supplemented with detailed explanations. The assumptions, bases and computations upon which the budget figures are predicated all should be recorded because they will later serve a vital purpose.

These figures are not the plan itself. They are only the external expression of the plan, in a language understandable to all. The statements are a mere vehicle with which to inform, appraise and perchance readjust. The substance of the plan itself is in the minds of its creators.

It would hardly be necessary to emphasize this self-evident truth if it were not ignored so often. It is of no value whatever to budget a given amount for advertising, for instance, without clear advance knowledge on the part of the advertising manager of the media to be used, the markets to be reached, the products to be advertised. In fact, the advertising budget does not qualify as a segment of a true operating plan unless the sales manager also understands the exact degree of support it will afford him in selling his forecast volume.

To be effective, planning cannot be superficial. It depends on a firm statement of principles by the top executive, a clear understanding by each man of the contribution his division or department is expected to make to the enterprise, and a willingness to plan with care and to stand back of the plan.

WHAT THE PLAN COVERS

Anyone who has taken part in the preparation of a plan of operations for an industrial company is aware that the undertaking is far more comprehensive than it may first appear. No activity of the company is exempt; every segment must be fitted into a master program.

Consider for a moment the implications of preparing a sales budget, sometimes referred to as a sales forecast, for a period of a year ahead. All products must be budgeted, including those which have not yet been introduced. Due weight must be given the general economic outlook and its bearing on the demand for the company's products. The effect on volume of proposed changes in merchandising methods must be considered. Both volume and selling prices must be planned, and this involves an advance determination of the quantities to be sold in each market or through each sales outlet.

Bear in mind that creative sales budgeting will not tolerate retrospection, astrology nor guesswork. The penalties are too severe. For example, the sales promotion budget will lean heavily on the planned sales volume. What is perhaps even more significant, so will factory production levels, purchase commitments and the ever-critical acquisition and layoff of production workers. Planning is a company-wide process of integration, in which no man can stand alone. All depend upon each other.

When the volume of planned sales has been established, the manufacturing division is in a position to plan production levels and times, as well as inventories. Manufacturing costs must then be fitted into the program, including material purchase prices, wage levels and even manufacturing efficiency. The planning process then fans out to include factory administration costs, research objectives, selling strategy and general administration. The spotlight is turned on the future course of each activity and each is reduced to budgeted figures.

Finally, when all this planning has been done and translated into the language of dollars—after financing decisions have been made and estimates of money costs and income taxes prepared—it is possible to arrive at the planned net profit. It is this figure which determines return on the capital invested in the business and willingness on the part of investors to provide more capital as required by its growth.

PLANNING IS A MAN-SIZED JOB

We have skimmed lightly over a process which sometimes taxes the capacity and judgment of every executive in the business. It is not an easy task to make major operating decisions for 12 months ahead and place them neatly on a timetable. Yet this is what must be done if the company is to operate under the kind of control that produces satisfactory results.

Sometimes these advance determinations are subject to subsequent revision. The planning process should accommodate this need. If decisions must be made subject to probable change, all concerned should understand the assumptions on which they are based and the extent to which the plan may have to be altered. Flexibility, not rigidity, is a characteristic of dynamic planning.

The dividend from this process is proportionate to the magnitude of the hurdles surmounted. First, there is time for deliberation on the problems appearing on the horizon, as contrasted with solving them at the last minute in an atmosphere of crisis. And second, the kind of interchange described in the foregoing illustration yields a mutual understanding of the basics of the business which could not be obtained in any other way. There is no comparable training course for executives.

CAPITAL EXPENDITURE PLANNING

Planning of the company's operations cannot be considered complete unless it is integrated wtih a plan for providing required new buildings, machinery, equipment, tools and so on. The needs of the organization in this area should be assembled as carefully as are the departmental operating budgets.

In this case, however, the term of planning is usually a little longer—say three years, as compared with the customary 12-month projection of sales and expenses. Capital requirements must be prepared on a long-range basis because of the time requirement for construction and procurement and because these items are largely charged against the income of future years.

Furthermore, such expenditures will largely govern the planning for financing. The logical outcome of this thinking is a phase of planning which is far broader than capital expenditures alone, and which might be referred to as a financial program.

In constructing such a program, estimates must be made of required operating cash, accounts receivable and inventories, as well as plant and equipment items for the planned period. In fact, every item on the company's balance sheet receives scrutiny in this process, and the resulting financial program may be expressed in terms of pro forma balance sheets for each of the succeeding three years. Obviously, borrowings, net profits, dividends and enlistments of new equity capital must be planned in order to accomplish this result.

The process of constructing a financial program is perhaps even more difficult than that of creating an operating plan for a one-year period. It requires that proposed major moves be frozen into at least tentative decisions, which can usually be made only by boards of directors.

REPORTING ON PERFORMANCE

It will be recalled that the control formula consists of (1) the adoption of a plan, (2) reporting actual performance as compared with the plan, and (3) making decisions and taking action. The second of these steps merits a brief discussion.

Probably the simplest known form of reporting performance against plan is the typical expense report issued by the accounting department, showing itemized expenses for the month, compared with budget figures. Too often the reporting ends there. It should add two other features: a written explanation of the figures where it would be helpful, and sympathetic consultation with the recipient of the figures. The latter should only be lengthy enough to ascertain that the man responsible really understands the meaning of the figures.

The same principle, of course, applies to profit-and-loss statements and to reporting on the performance of any unit of the business. The reporting cannot be perfunctory. It must be based on an intimate knowledge of the operation and of the plan itself, rather than merely on the figures. For instance, it is far more significant to point out a deviation from a

planned expansion of the sales force than to report only that salaries are so many dollars less than the amount budgeted.

DECISION AND ACTION

The final step in the control formula is decision and action. When the planning has been done properly and adequate reporting has been made on performance against the plan, the ensuing decisions sometimes become surprisingly clear. The action is frequently indicated in the reporting itself.

Assume, for example, a failure of actual manufacturing cost to match the planned cost for a given month. The result, of course, shows up in a deficient net profit. The excess of actual over budgeted or planned cost has been traced to its source. It is relatively easy to do this if the plan has been constructed in adequate detail by the manufacturing organization. Whether the reason be low production volume, high material prices, heavy waste losses, or any of the myriad of other happenings which push costs upward, management is faced at once with a clear-cut decision. Either the condition must be corrected, or, if this is not possible, other changes in the plan must be made to compensate for it. Planned expenses, costs or sales volume must be improved, or planned net profit must be reduced.

The decision should be reached in an atmosphere of participation by everyone concerned. If an adjustment is made in the plan itself, each responsible executive and supervisor accepts the full impact of the change on the performance expected of him.

In practice, an orderly method is required for revision of the operating plan and reflection of the change in the projected operating figures. For example, it may be advisable to give effect to new planning and changes in plan only at three-month intervals, in the course of a complete revision of budgets. Interim deviations, meanwhile, are made conspicuous, in harmony with the best management-by-exception tradition.

By these devices of control, all units of the business are coordinated. The simple triad, planning-reporting-action, becomes the guiding principle of the business.

WHO IS RESPONSIBLE?

It is a long step from the resolution to have better planning and control to its actual realization. As in every other advance in management method, responsibility must be fixed at the outset. In this case, however, the assignment of responsibility is decidedly complex.

Fundamentally, every manager or supervisor in charge of a unit of the business well enough defined to have a budget of its own must be made responsible for the planning and control of that unit. By implication, the responsibility travels up the organization line all the way to the top.

The president, of course, is ultimately charged with the obligation of success in this field, as in all others, and he therefore must undertake to see that the control mechanism is constructed and maintained and that the entire organization is educated in its use.

Because this multiple task is so time-consuming, experience has proven the wisdom of assigning it to a staff executive who may be referred to as the controller.

Essentially the burden of installation, education and follow-up falls on the president and the controller. The respective areas of action of these two executives require a little further comment.

THE PRESIDENT'S RESPONSIBILITY

It is axiomatic that all policies of management must enjoy the unqualified support of the top man in the business. Planning and control techniques are no exception. The company's president must understand them, use them himself and furnish the required leadership in their application.

It is probably self-evident that the same comments apply, in degree, to executive vice presidents, division and department managers and others. The acceptance and use of the planning and control concept must be commensurate with the authority invested. It is the president's task to create an understanding of these points in his immediate subordinates, who in turn are held accountable for transmitting this understanding and making control effective throughout their respective spheres of activity.

THE CONTROLLER'S RESPONSIBILITY

It should be re-emphasized that the control function, within the concept we are discussing is not always assigned to an executive with the title of controller. It is frequently found to reside in a top financial or administrative officer, and sometimes remains in the hands of the chief executive.

DEFINITION OF CONTROLLERSHIP

As defined by the Controllers Institute of America, the functions of controllership include establishing, coordinating and maintaining an integrated plan for the control of operations, but it is specified that this must be done through authorized management. Such a plan, it is stated, would provide cost standards, expense budgets, sales forecasts, profit

planning and programs for capital investment and financing, together with the necessary procedures to effectuate the plan. The important words in this assignment are "through authorized management" and this little phrase sets the keynote for the controller's peculiar mode of getting things accomplished. He himself should never establish a single standard or budget (except his own), nor a single sales forecast. The plan must be constructed, under his helpful guidance, by the operating executives who will have to accept the responsibility for performance.

The Institute's definition then assigns to the controller the duty of measuring performance against approved operating plans and standards, and of reporting and interpreting the results of operations to all levels of management. It is within this assignment that he finds the need for designing, installing and maintaining accounting and cost systems and records, determining accounting policy and compiling statistics.

Other parts of the definition equip the controller with power to measure, interpret and report on almost anything—even the validity of the objectives of the business—and to consult with all responsible segments of management on any phase of the operation of the business. He is also charged with the duty of interpreting economic and social influences in their impact on the business. He is free, in fact, to offer his constructive thinking wherever he feels that it will contribute to more effective planning, direction, control.

A discreet controller can exercise this wide latitude without offense to his fellow executives, provided he heeds the ground rules of controllership. These include a fastidious abstention from taking on operating responsibilities or making operating decisions; reporting consistently to all concerned; insisting that the line organization determine their own budgets and standards of performance; and above all, reporting and interpreting without exaggeration, bias or regard for the preconceptions of others.

In particular also, he must not take operating people to task for failure to meet the standards, and he must not be placed in the position of making negative decisions on spending money. It is a familiar myth that these unpleasant attributes are the characteristics of a controller. The penalty for permitting this misconception to be accepted among his associates is the sacrifice of controllership effectiveness.

The particular state of mind that the controller ought to impart to the organization is a sense of balance, stability and direction.

THE ROAD AHEAD

It would be unfortunate to leave the impression that planning and control solve all the problems of running a business. Planning and control

simply facilitate the solution of these problems very materially and open up possibilities of achievement which could not be realized otherwise. In a word, it represents thinking forward instead of meeting each daily crisis when it arises. It represents detailed knowledge of where and why we are going astray, as contrasted with a tardy awakening to developments which have been buried for too long in the debris of current affairs. Its fruition is a priceless sense of knowing where we are going rather than steering a blind course.

This is a present possibility. We are just beginning to learn the unlimited benefits of wisely conducted planning and of control constructively applied. New and better methods will constantly improve the practice of planning and control, but its unchanging principles, symbolized by the planning-reporting-action formula, are the eternal possession of business management from the time of their discovery.

2. THE MANAGER CONCEPT: A RATIONAL SYNTHESIS

Robert Tannenbaum*

Professor Robert Tannenbaum defines a manager as an individual who "has and uses formal authority to organize, direct, or control responsible subordinates." In the following excerpt from a larger article he discusses the scope of this definition. A review of the literature pertaining to management, which forms a large section of the total article, has been omitted in the following material.

An enterprise may be viewed as an instrument for the transformation of the services of persons and things into completed product. Of the personal services contributed to an enterprise, some are managerial in character; others, nonmanagerial. Those who contribute managerial services will be called managers, while those who contribute nonmanagerial services (although usually called workers or laborers) will be called nonmanagers.

This article is primarily concerned with the nature of managerial services. The problem is in clearly differentiating them from nonmanagerial services. Such differentiation can best be accomplished by isolating those functions performed exclusively by managers.

* From *The Journal of Business*, XXII, 4 (1949), 225-41. Reprinted by permission of the University of Chicago Press.

Taking into account the definitions employed and differing terminological usages, eliminating in most cases terms which represent processes, techniques, or tools, and allowing for ambiguities, it is possible to classify into five groups the various functions discussed by the writers. Each group is characterized by the fact that (*a*) the functions of which it is comprised are the same or similar but are assigned different names or (*b*) that the functions are different but are closely related or (*c*) that they overlap in content

In the first group are "organization," "lay out the broad lines of administrative structure," and "develop and maintain a system of communication which jointly involves a scheme of organization and an executive personnel." In the second group are "initiation and approval of decisions," "planning," "formulate and define the purposes, objectives, ends, of the organization," "formulation and determination of policy," and "direction." In the third group are the terms "control," "supervision," and "appraisal." In the fourth group are "inspiration," "motivation," "leadership," and "promote the securing of personal services." And in the fifth group are "trusteeship" and "representation." Finally, it should be noted that "co-ordination" appears as a function in many of the quotations.

This grouping of the functions of managers as presented by various writers provides a convenient basis for the development of a synthesis of the manager concept which is attempted in the following section.

THE FUNCTIONS OF MANAGERS: A SYNTHESIS

The functions in general.—The functions of managers may now be listed and discussed in detail. No claim to complete originality is made for this presentation. It represents, for the most part, an effort logically to combine selected ideas of many writers into a meaningful and useful functional definition of the manager.

No special brief is held for the terminology chosen or for the particular grouping of activities used.

In speaking of the functions of managers, it is not intended to imply that each manager in an enterprise performs all the functions. Such is seldom, if ever, the case. Managers, like nonmanagers, are specialists. They typically specialize in specific functions or a specific function. The functions of managers are those performed exclusively by managers as a group.

It is the thesis of the present discussion that all managerial activities are included in three functions: organization, direction, and control. These are derived from the groupings presented at the conclusion of the preceding section and will now be discussed.

Organization.—The term "organization" implies an arrangement in which all units are so related to each other that they may work as a whole, each unit having its proper task to perform,[1] and "to organize" means "to arrange or constitute in interdependent parts, each having a special function, act, office, or relation with respect to the whole."[2] These statements include two basic concepts, namely, units or parts each having its proper or special task to perform and an arrangement involving an interdependence or relationship between the units or parts. The managerial function of organization involves these two concepts. Managers must determine the degree and type of specialization to be effectuated within the enterprise and they must determine the relationships that are to exist among the specialized units.

With respect to the degree and type of specialization, one of the characteristics of the individuals, groups, and complexes comprising an enterprise is that they each contribute specialized services to the group or complex of which they are a part. The determination of these specializations involves analysis first and then synthesis.

The function of organization begins with the objective of the enterprise, i.e., with the good or service to be produced. It must be determined by analysis what services of individuals will be necessary to produce the good or service in question. This determination entails questions relating to both degree and type. How specialized should be the services to be contributed by each individual occupying a position, and what should be the type of these services? Both of these questions must be answered. When they are, the process of synthesis can begin. First, the individuals contributing specialized services must be combined into groups. The nature of these groups is similarly determined by the degree and type of group specialization desired. Next, groups are combined into complexes and these into superior complexes and so on until the supreme complex is achieved: and always the degree and type of specialization are the determinants of the nature of each of these units.

The services contributed by the managers who comprise the managerial superstructure are also specialized; and the determination of the degree and type of the specialization of these services must be made by managers. Certain aspects of this determination lead to a consideration of the second concept involved in the managerial function of organization, namely, the determination of the relationships that are to exist among the specialized units in an enterprise.

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[1] Cf. "Order," *Webster's Dictionary of Synonyms* (Springfield, Mass.: G. & C. Merriam Co., 1942).

[2] "Organize," *Webster's New International Dictionary* (2d ed.; Springfield, Mass.: G. & C. Merriam Co., 1924).

The relationships established among the managers of an enterprise determine the relationships among the groups and complexes which they head. So it is upon the former relationships that attention must be focused. The managerial relationships are always expressed in terms of authority and responsibility, and they are established by delegation. Therefore, each of these three concepts must first be defined.

Authority is the right to command or to act. Thus, a person having authority has the right not only to act himself but also to expect action of others. But what is the source of this right? In practice, authority appears to originate at the top of a structural hierarchy—under private enterprise, with the owners—and to flow from owners to their representatives, the managers, and from superior managers to their subordinates. Hereafter in this presentation, authority, when viewed in this customary manner, will be referred to as formal authority.

Responsibility involves being subject to another who may exact redress in case of default. Responsibility is answerability or accountability. One is typically responsible to another for the performance of tasks assigned to him by the latter.

Delegation is the act of investing with formal authority to act for another. "Delegation always means the conferring of authority, and can never mean anything else."[3] A delegation of formal authority must always include a definition of the limits within which that authority may be exercised.

As has been indicated, the fountainhead of all formal authority in a private enterprise is the owners—in a corporation, the stockholders. The latter typically retain some formal authority but delegate most of it to their elected representatives, the board of directors. The board, in turn, becomes responsible to the stockholders for exercising the delegated formal authority within the specified limits. The board retains some formal authority and delegates the balance to the manager who heads the supreme complex. The delegation establishes the specialization for this manager, and he becomes responsible to the board within the limits of the delegation. This process continues downward through the managers of superior and subordinate complexes to the managers of groups. The latter delegate to the individuals comprising their groups formal authority to perform designated tasks, and the individuals become responsible for such performance. *These individuals are never delegated formal authority to command, nor are they able to delegate authority to others.*

A manager who delegates formal authority to subordinates does not thereby escape responsibility to his superior for the exercise of the formal authority which the latter delegated to him. He is able to assume

[3] James D. Mooney and Alan C. Reiley, *The Principles of Organization* (New York: Harper & Brothers, 1939), p. 17.

that responsibility by holding his own subordinates responsible for the formal authority which he has delegated to them.

The formal authority which is delegated to subordinates may itself be specialized into the authority to prescribe and the authority to enforce. The former is authority to indicate how designated activities shall be performed, the latter is authority to see that the activities are performed; some managers exercise both types of authority, others, only one type. Formal authority may also be centralized or decentralized. The more centralized the authority, the more it has been reserved for execution by managers at the higher levels in the managerial superstructure; the more decentralized the authority, the more it has been delegated to the managers at the lower levels in the managerial superstructure.

The process of delegation establishes definite relationships between managers and therefore between the specialized groups and complexes which they head. These relationships are those of superior and subordinate. A subordinate is always responsible to a superior for the accomplishment of that for which he has been delegated formal authority. Formal authority is delegated downward through the managerial hierarchy; responsibility extends upward through the same hierarchy. The superior-subordinate interconnections are the channels of formal communication, both downward and upward, within an enterprise; and the managers are themselves the centers of communication.

Direction.—Once managers have determined the degree and type of specialization to be effectuated within the enterprise and the relationships that are to exist among the specialized units, they have provided themselves with a mechanism for the attainment of purpose. They must next employ the mechanism. The first function of managers involving such employment is the function of direction. Direction is the use of formal authority in order to guide subordinates. Direction involves the devising of the purposes of action and the methods or procedures to be followed in achieving them. The decisions to be made in connection with direction must answer the questions "what?" "how?" "when?" and "where?"

The devising of the purposes of action provides the "what-content" of direction. It has already been seen that the individuals comprising groups, the groups comprising complexes, and the subordinate complexes comprising superior complexes must in each case have an enterprise purpose, end, or objective. In addition, each individual manager and non-manager, has a purpose to achieve in his own activity. Managers must formulate these purposes for their subordinates and order them put into effect.

The devising of purposes begins with the broad purpose or purposes of the enterprise. These are then translated into subpurposes for the superior complexes comprising the supreme complex. The subpurposes are further subdivided for the subordinate complexes, and so on down the structural hierarchy until each individual has his own purpose. These translations or subdivisions are made successively by managers, starting with those at the top of the hierarchy of the managerial superstructure (typically the board of directors) and moving down to those who head groups.

The devising of methods or procedures to be followed in achieving purposes provides the "how-," "when-," and "where-content" of direction. Here, again, the broad and general decisions are made by managers at the top of the managerial hierarchy, and these decisions are made ever more specific by successive subordinates down through that hierarchy.

Directive decisions, once made, serve as a basis for the guidance of action. The vast majority of directive decisions are made to guide subordinates in actions which are repeated frequently. Relatively few such decisions are made to guide actions which are performed but once. In the case of any action frequently repeated, a tremendous burden would be placed on managers if a duplicate decision had to be made each time the action were to be repeated. To avoid this unnecessary duplication in decision-making, managers have developed numerous devices or tools to be used in providing guidance for repetitive action. In practice these devices are variously referred to as "budgets," "policies," "procedures," "practices," "methods," "rules," "regulations," "routines," "schedules," "instructions," "specifications," "designs" etc.[4] The importance of these devices to managers cannot be overly stressed. Because they obviate the necessity for redeciding questions, they release for other purposes much valuable time which otherwise would have to be devoted to such redecision. These devices are also used by managers as criteria of action, since each of them implies a standard of performance to be attained. Serving as a guide to action and a criterion of action are simply two aspects of the same thing.

[4] Some of these terms are by no means mutually exclusive from the point of view of definition. Furthermore, in practice they are often used to refer to different things. There is a crying need for standardized terminology here. The term "policy" provides an excellent example of this need. It has been used in so many ways that it is necessary for each user to define the term in order for it to have any precise meaning in the context in which it is used by him. See Chester I. Barnard, "Comments on the Job of an Executive," *Harvard Business Review*, XVIII, No. 3 (spring, 1940), 296.

Control.—The second function of managers involving the employment of the mechanism for the attainment of purpose (the organization) is the function of control. Control is the use of formal authority to assure, to the extent possible, the attainment of the purposes of action by the methods or procedures which have been devised. The execution of this function involves the selection and training of individuals, the provision of incentives, and the exercise of supervision. These components of the function of control (selection and training, incentives, and supervision) may appear at first glance to be unrelated activities. They do, to some extent, involve different managerial techniques. However, each is essential to the attainment of purpose by the methods or procedures which have been devised and is therefore logically classified under the function of control as defined.

One aspect of the function of organization previously discussed is the determination by managers of the degree and type of specialization to be effectuated within an enterprise. In part, this determination results in specifications of the types of services which will be required of individuals. Managers must next match these specifications with individuals—managers and nonmanagers—able to contribute the desired types of services. Such individuals may be found either within or without the enterprise. If they are found, they may be selected to fill positions calling for the types of services they are able to contribute. If such individuals are not found, then other individuals, either from within or without the enterprise, with the capacity for contributing the desired services must be selected and then trained until their capacity becomes ability.

The task of matching individuals with specifications is not an easy one. An individual's ability to contribute the desired types of services is often closely related to such intangible personal factors as his character, personality, temperament, and the like; and when individuals work together in co-operative groups, these factors are important determinants of interpersonal compatibility. Since no completely adequate measures of these factors have as yet been devised, the selection of individuals requires the exercise of judgment on the part of the manager making the selection.

Now, each manager is responsible to his superior for the accomplishment of assigned tasks; and since the ability of a manager to meet such responsibility depends in part on the quality of his subordinates, and since the determination of that quality is based to a greater or less extent on the exercise of judgment, he must be able to select his own subordinates. In no other way can he reasonably be held for their performance. The selection of subordinates is particularly crucial from the point of view of control when those subordinates are themselves managers. This is true because

the intangible personal factors play such an important role in their work.

By selecting subordinates and training them when necessary, managers try to provide themselves with individuals able to contribute the types of services necessary for the attainment of purpose. Any single manager can reasonably be held responsible for such attainment only if he has been the one whose judgment has determined the ability of his subordinates.[5]

It is not enough that individuals be found who are able (or who can be trained to be able) to contribute desired services to the enterprise. They must also be willing to do so. Ability must be supplemented by strong motivation. Unlike the flow of services from a machine, that from an individual is subject to considerable variation in intensity through time depending upon the motivation of the individual; thus it becomes necessary not only to make individuals willing to contribute desired services but to regulate as far as possible the intensity of the flow of the services. Incentives must be provided for these purposes.

An incentive as here viewed is any device which is offered to induce an individual—manager or nonmanager—to contribute services at a desired intensity to an enterprise. The inducements which may be offered to motivate an individual are numerous. They include various materials things: opportunities for distinction, prestige, personal power, and the like; desirable physical conditions of work; pride of workmanship, sense of adequacy, feelings of altruism, loyalty, etc.; social compatibility; customary working conditions and conformity to habitual practices and attitudes; opportunity for the feeling of participation in the course of events; solidarity or satisfaction of the gregarious instinct; and coercion. The proper use of incentives by a manager is a method by which he may secure and regulate the service contributions of subordinates that are so essential to the attainment of the purpose for which he is responsible.

Individuals who are able and adequately motivated to contribute services may still, for many reasons, execute commands imperfectly. It will be recalled that directive decisions are often expressed in terms of criteria of action or standards of performance. The observation of performance, the comparison of it with the predetermined criteria or standards, and the taking of remedial steps where called for are essential if the purposes of action are to be attained by the methods or procedures which have been devised.

[5] Many writers view selection as being a phase of the function of organization. To these writers, organization includes both structural and staffing considerations. A good case can be made for this point of view. I prefer, however, to include selection within the function of control. To me, the right to select subordinates—particularly managerial subordinates—is so essential to an assurance of the attainment of purpose that selection seems most properly classifiable as a phase of the managerial function of control.

These entail the exercise of supervision.[6] Supervision involves overseeing, inspection, the use of accounting and statistical devices, the use of reports, etc., for the purpose of determining the facts of performance; and it involves appraisal or evaluation for the purpose of comparing performance with standards. It is important to recognize that supervision is exercised not only by the managers of groups but by all managers who have subordinates, including the manager of the supreme complex and the board of directors.

A comment on the managerial technique of command.—Command is a managerial technique used in connection with the execution of all the functions of managers. A command is an order from a superior to a subordinate to do something. Through command organizational, directive, and control decisions can be translated into action. Command, therefore, is (along with decision-making) probably one of the most important and pervasive of the managerial techniques.

Additional "functions" considered.—In the classification of functions based on the formulations of other writers "trusteeship" and "representation" comprised the fifth group of functions. In the writer's opinion, the so-called "function of representation" is not one of those functions performed exclusively by managers, nor can it serve as a basis for differentiating managers from nonmanagers.

It is often pointed out that managers must represent the enterprise, or some portion thereof, in dealings with such external units as stockholders, consumers, suppliers of goods used by the enterprise, organized labor, competitors (either individually or in trade associations), government units, the general public, etc. Managers speak and act for the units they manage. They often enter into contracts with an external unit, acting as

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[6] Many writers use the word "control" to stand for that which I designate by "supervision." Others follow the practice I do. Still others use the words "appraisal" or "evaluation." Here, as before, no available word is completely satisfactory to connote all that one would desire. The weakness of "supervision" is that it often implies work carried on by those near the bottom of the managerial hierarchy. Regardless of the word used, the ideas behind the words are usually similar; e.g., Brech: "'Continuous control and supervision of the activities of the organisation' is nothing else than the obverse of planning. It is the task of seeing that the plans laid down are being currently and effectively carried out, or establishing good reasons for failures and departures." (E. F. L. Brech, *The Nature and Significance of Management* [London, 1946], p. 16). Fayol: "Control . . . he [Fayol] regarded as an aspect of Administration. He defined it as, 'Seeing that everything is being carried out in accordance with the plan which has been adopted, the orders which have been given, and the principles which have been laid down.'" (L. Urwick, *The Elements of Administration* [New York: Harper & Brothers, 1943], p. 105.) Copeland: "After a plan is in operation, the executive has the task of checking up to learn whether it is being carried out in accordance with the policy formulated to meet the conditions and with the sequence and timing decided upon. This follow-through is the essence of executive control" (Melvin T. Copeland, "The Job of an Executive," *Harvard Business Review,* XVIII, No. 2 [winter, 1940], 158).

an agent of the enterprise of which they are a member. All of this is true, but it is also true, at times, of nonmanagers as well. The act of representation on the part of a nonmanager is never sufficient in practice to give him the status of a manager.

In this connection, it is important to note that all the services contributed by certain individuals to an enterprise are not necessarily managerial in character. Managers often reserve to themselves some nonmanagerial work to perform which they consider too important to delegate to someone else. Much representation work performed by managers is of this character.

It was also noted that many writers consider co-ordination to be a function of managers. Again the writer disagrees with such a point of view.

MANAGERS AND NONMANAGERS DIFFERENTIATED

At the outset of this article, it was indicated that primary concern would be with differentiating managerial services from nonmanagerial services and that this could best be accomplished by isolating those functions performed exclusively by managers. Such isolation has been attempted. Now the separate threads of this article can be drawn together and combined into meaningful conclusions.

It is the thesis of this study that managers are those who use formal authority to organize, direct, or control responsible subordinates (and therefore, indirectly, the groups or complexes which they may head) in order that all service contributions be co-ordinated in the attainment of an enterprise purpose.

Managers always stand in a relationship of formal authority over subordinates who, in turn, are responsible to their superior. Managers use formal authority in order to execute the functions of managers—organization, direction, and control. The objective of the execution of the functions is the co-ordination of service contributions in the attainment of an enterprise purpose. *An individual is not a manager, does not manage, unless he has and uses formal authority to organize, direct, or control responsible subordinates.* In business enterprises individuals may be called managers who do not fit this specification. From our point of view, they are managers in name only. In determining who is a manager, one must look to functions performed and not to titles. *Unless he conforms to this specification, he is a nonmanager.*

When specialized services are being contributed toward the attainment of an enterprise purpose, co-ordination is essential. This co-ordination is supplied by managers through their execution of the functions of managers. Many writers consider co-ordination to be a function of managers.

Co-ordination is not properly a function; it is something to be achieved. And it is achieved by adequate organization, direction, and control. *The services of managers (involving organization, direction, and control) are necessary to co-ordinate the specialized service-contributions of the units which they head in the attainment of an enterprise purpose. The services of managers are needed for no other reason.*

From what has been said it can be seen that managers can be differentiated from nonmanagers.[7] Managers always have subordinates; nonmanagers never do. Nonmanagers may organize, direct, or control (in a sense) themselves or the material objects with which they work, but they never organize, direct, or control responsible subordinates. Furthermore, it is important to see that managers as well as nonmanagers may be managed. All managers, except the one (or ones) who heads the supreme complex, are managed by their superiors. They, in turn, manage their subordinates. The crucial distinction to be made is between managers and nonmanagers —not between managers and the managed.

One final point needs emphasis. The services of all individuals are essential if the purpose of the enterprise is to be attained. The distinction between managers and nonmanagers is based on differences in the types of specialized services contributed by the two groups and on no other criterion.

3. MANAGEMENT CONTROL

Alex W. Rathe*

Professor Alex W. Rathe regards management control as an executive's instrument panel. An important but brief element in this article is the "feedback" of current control data to the planning group for use in future planning; this is illustrated also in the diagram of the author's concept of management control.

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[7] This statement is contrary to the opinion of some other writers. For example, Brown says: "*Management* has been very widely used in the literature of business to denote both the act of management and those who manage. As so used, it represents the concept of an upper tier of endeavor which can never be exactly defined. Because it cannot be defined, this treatise has concluded that, however useful the notion may be in treating of administration in general, it does not help in understanding organization. Those who 'manage' have responsibilities which differ from other responsibilities only in scope. Their acts are acts of administration differing only in scope from any act of administration. The authority which they exercise differs only in like manner. Indeed, the distinction between management and labor is a highly artificial one which probably has not helped our social economy." (Alvin Brown, *Organization* [New York: Hibbert Printing Co., 1945], p. 104, n. 1.)

* From *Advanced Management,* XV, 3 (1950), 9-11. Reprinted by permission of *Advanced Management.*

No pilot flies a plane without navigating instruments which guide him to his target. The Executive's Instrument Panel which guides progressive business to its target is Management Control.

CONTROL PRINCIPLES

"Control" of operations is good only when it helps operations. Does this not mean . . .

1. That control must give warnings of obstacles which lie ahead and that it should map out plans to avoid them.
2. That control must examine past and present activities so as to search out weaknesses which can be eliminated in the future, and that it has to ascertain the results of its planning.

The first point covers planning activities. They determine what *should* take place. The second indicates control activities. They determine what *did* take place. Separated, each is vulnerable. Grouped together, planning and control work is a powerful managerial instrument. It operates in a cycle. Plans are formulated, tried out, and checked; their results influence new plans which are put into operation and tested again; and so forth in a continuing chain reaction.

When properly organized, these techniques produce such potent results that they have been called "the new look in management." In less commercialized appellation, the interplay of planning and control has become known as Management Control.

We need both planning and control in this task of improving management. The primary reason is perhaps that control is most effectively exercised before something goes off the beam; for that, you need to know what should take place—what the plans are—so as to be able to guide matters there.

Furthermore, it is difficult to separate planning and control in many instances. The budget, for example, is a planning tool; it sets forth the schedule of operations decided upon. But marking against the columns of "budgeted" data the corresponding figures of "actual" performance brings forth the control aspects of the budget; this is particularly so when there are added comparable data on operations during the previous season or on activities in some other place.

Time standards serve both planning and control because they facilitate planning while comparison of actual with standard time serves the control end.

THE PLANNING PHASE

The planning phase of management control determines how operations should proceed. This is a formidable job; depending upon individual circumstances, it varies considerably in scope; Figure 1 shows a relatively

wide range. So many of the planning activities are problems which the line executive, in the pressure of everyday operating responsibilities, is forced to postpone for the proverbial tomorrow which too often never comes. He usually welcomes the assistance in these projects of a staff agency such as the Controller's Division which will be sketched here.

Planning has two segments. First, the operating program must be designed and secondly, managerial tools are to be developed which permit this program to be executed in the best manner.

With policies as reference points, long range plans and short term programs are designed. Long range plans peer three, five, or ten years into the future. They cover any and all phases of corporate activities.

For the short range program the foundation is laid by market analysis which ascertains the market potential. Sales forecasts calculate the probable share of this total demand which the company can expect to fill. This estimate is reconciled with the results of a separate study of economic conditions and then, the corporation's over-all short term program evolves, with its component engineering, manufacturing, marketing, and other divisional programs.

THE CONTROL PHASE

The first control task is to locate those spots in all parts of corporate activities which compile significant factual data on performance and to synchronize them into one over-all management control network.

Financial data come from three main reservoirs. Cost accounting is the custodian of the expense records of operations, parts, products, departments, or other subdivisions. The second carrier of financial information is the budget. Its clear-cut schedules, listing the plans for all important financial transactions, represent the operating program in monetary terms. Financial auditing is the third of the contributories to the stream of financial data.

All other data, trends, events, and additional facts should be collected, recorded, and analyzed by a statistical group; its pipelines connect with production control, payroll, timekeeping, purchasing, quality control, sales, and many other records.

After all these control data are collected, they are analyzed.

The really responsible part of the job is the evaluation of these findings. This is where the management control group meets its acid test. Data and facts must be interpreted in the light of existing circumstances. They should be evaluated from the point of view of over-all management. And most importantly, they have to be examined in their relation to, and influence upon, one another. Thorough consideration has to be given to economic, human and public relations as well as many other aspects. Main

emphasis does not rest so much on analysis but on synthesis of the components of the findings.

The results of the evaluation are usually compiled in reports. They are also often presented to the executives concerned in less formal fashion, somewhat in the manner in which a physician would discuss with a colleague the results of his diagnosis and experiments. Whether it is the counsel of the doctor or of the controller, it is entirely within the individual's discretion to accept or reject the advice offered.

The findings are finally channeled back to the planning group so that they will be considered in future developments, policies, plans, and programs. This "feed-back" completes the cycle of management control work.

The bird's-eye view shows at once that management control is not synonymous with economics, statistics, accounting, or engineering. It contains elements of all of these, and much more because, as the Executive's Instrument Panel, it gives an account of all operational aspects in all phases of the company.

ORGANIZING FOR CONTROL

The first requirement for organizing the management control function will always remain that the solution is acceptable on the psychological front.

That is why management control is usually decentralized. In this manner, closer relationships become possible and greater interest in the work is generated because everyone sees what he contributes and what his contributions mean in the larger picture. The nearer you get to the specific operation, the more effective is your control and the more readily are control findings accepted.

Decentralized, each division, store, or plant has its own management control staff, its own subsidiary instrument panel. Here are performed all planning and control activities for the group. A selection of typical assignments for the functional divisions of a manufacturing company might for instance be . . .

"PROGRAMS"

Marketing	sales forecast
Manufacturing	manufacturing program delivery timetable production control schedule

"TOOLS"

Finance	accounting procedures
Production	methods

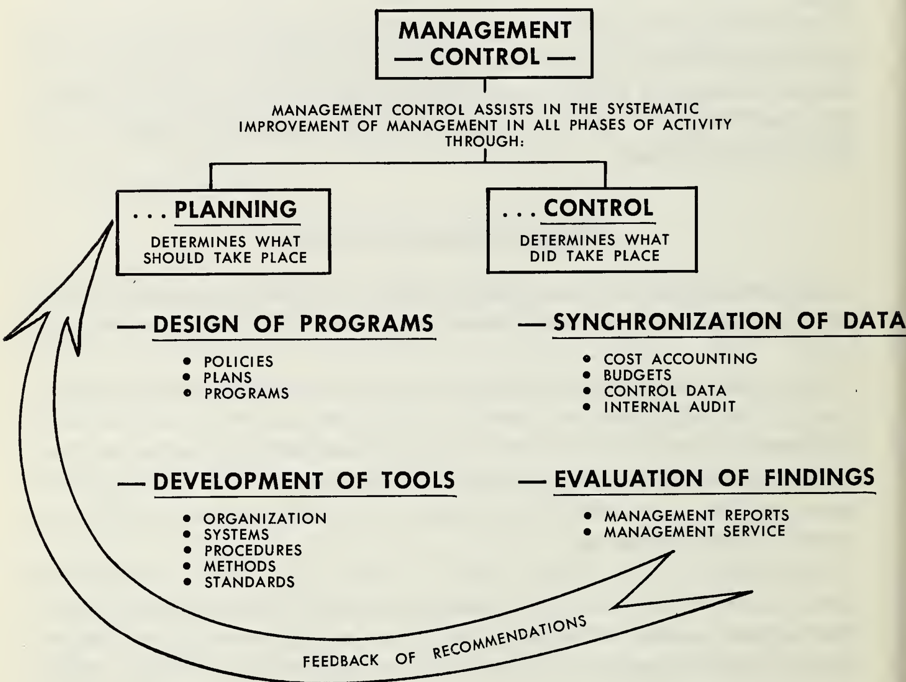
"DATA"

Engineering	development cost divisional budget other engineering data

"EVALUATION"

Personnel	morale survey

Management Control: The Executive's Instrument Panel



This then leaves the Controller with four main spheres:

First, he has to connect the subsidiary instruments in the various divisions into an over-all corporate instrument panel from which top executives and division managers alike obtain their reading on the course and the performance of the enterprise as a whole.

Second, he handles projects of mutual concern and acts as a clearing house for the exchange of data, information, and advice on problems of

common interest to several divisions (such as corporate organization structure).

Third, he is responsible for corporation-wide problems which affect all divisions (such as economic studies, over-all policies, etc.).

Fourth, his staff is available to all other divisions as the company's own management consultant whenever such services are desired; and this is usually the case with a great variety of problems.

CONTROL IN PRACTICE

Three considerations are paramount if management control is to be successful:

One, planning and control activities must be recognized as components of one task, that of managing; they are not a tool but a part of management.

Two, the profitable functioning of management control depends on reliable interconnection not merely of some but of all planning and control work wherever it may be carried on in a firm.

Three, decision by factual data is to be emphasized, rather than a hit-or-miss approach, because you can't get the better way of tomorrow until you have all the facts of today.

Management control reinforces the executive whom it serves. It multiplies his effectiveness. But it has no command authority. It is confined to the authority of ideas, findings, and suggestions. It does not give orders. It must *sell* its recommendations. Or better still, it must present its thoughts in such a form that the operating executives want to *buy.*

Management control backstops management. In its planning phase, it determines the atmosphere—economic and otherwise—within which operations are expected to be carried out. It lays plans. It sets targets. It suggests the best road map and timetable through which the executive can reach his target.

And then, in its control phase, management control tells him what kind of a job he really did. It helps uncover errors made while pursuing the plans or deviating from them. It gives this information in clear-cut facts and figures. There is no hunch, no guesswork, no opinions. Management control is *fact* not *man* control.

In addition to supplying factual information on all phases of operations, management control evaluates these facts. It gauges actual performance against plans. It interprets results. It adds recommendations on how to prevent weak spots and avoid pitfalls in the future. Finally, it supplies practical ideas on how to proceed to make an ever-better record of profit and service and it channels them back into the planning phase.

4. OPERATIONAL AUDITING

Bradford Cadmus*

The need for the periodic and comprehensive survey and appraisal of all functions of a unit or cross-section of an enterprise is gaining increasing recognition. Who is to do this job? One answer is the internal auditor, and Mr. Cadmus gives a program approach for the guidance of management as well as the internal auditor.

We live in an age in which some previously clear-cut distinctions have broken down or have disappeared. For example, when I took a course in chemistry, there was a definite division between organic and inorganic chemistry. The chemist of today gives little or no recognition to this separation. Similarly, matter and energy were considered to be separate until atomic scientists changed that idea.

In the same way, financial and operational auditing are not—and should not be—separate and distinct types of auditing. To a very considerable degree, the techniques that we propose to describe as applicable to operational auditing apply to internal auditing of any description and in any department of a company. Yet there are certain differences that must be taken into account in the auditor's approach and his work in various departments. From the auditor's standpoint, these departments may be divided into two groups—corporate service and operating.

By corporate service departments we mean departments handling such functions as accounting, treasury, legal, taxes and insurance. To a very large degree, the work of these departments is conditioned by the requirements and the reports of the rest of the business. What will be recorded and reported is based upon decisions, policies and happenings that have originated in other departments. In audits of corporate service departments the internal auditor makes a constructive contribution as (1) he makes findings in matters of policy, procedure and reporting which lead to more effective operation of these departments and (2) as he finds clues in these audits which lead back to the operating departments.

Now, I propose that we center our attention on all corporate functions other than those which have just been defined as corporate service. To put it positively, let us assume that you are faced with an assignment from management to conduct audits of the purchasing, traffic, production, sales, advertising, engineering and research operations of your company.

* From *The Internal Auditor,* XVII, 1 (1960), 28-39. Reprinted by permission of the author and the Institute of Internal Auditors.

The first reaction of one who is not an internal auditor—and possibly of some internal auditors who have concentrated on financial audits—might be to wonder what sort of superman would have the knowledge and background to cover these diverse operations and be able to make a constructive contribution. The answer is simple—the internal auditor is an expert in control, not in operations. Every department of a company has organization, procedures, records, reports and some sort of formal or informal standards by which it appraises its performance. These are the controls, and these controls will be found in some form or other in every operating department. So the internal auditor can apply his knowledge of the techniques and principles of control to any department, just as a man familiar with the techniques of purchasing uses his talents in the purchasing department to buy what is required throughout the company.

ELEMENTS OF CONTROL

Description of the elements of control will be found in a number of publications. To give the essentials:

1. Organization control requires that each employee know his place in the organization and exactly what authority and responsibility have been assigned to him. Additionally, organizational control requires adequate checks and balances with separation between operating responsibility and the accounting for that responsibility.

2. Procedures have the objective of dividing and defining the work to be done into logical, understandable sections that specify the work and responsibility of each employee.

3. Records include accounting and all other records which show what has occurred—as a basis for information and reports.

4. Reports are a major means of management control. Both records and reports must be prompt, accurate, concise and complete. Reports must be (1) impartial in presenting a fair picture and (2) adaptable to administrative use, following the pattern of organizational responsibility.

5. Standards of performance provide the means of judging how what has occurred compares with what was expected or planned. Commonly used standards of performance are budgets, standard costs and comparisons with preceding periods.

THE INTERNAL AUDITOR'S TALENTS

Before we discuss the actual work of audit in the operating department, let us summarize the talents that the internal auditor brings to his task that qualify him to do a profitable and constructive piece of work in his assignment.

1. His knowledge of the techniques and philosophy of control, which have just been described.

2. His knowledge of his company. In this respect, he will usually be better informed than those with whom he is dealing. Through actual experience in various departments, he will know what is done, how it is done and how it fits into the over-all company operations.

3. His business sense—that sense of proportion which weighs the relative importance of each element of a situation in relation to the welfare of the business as a whole.

4. His innate curiosity about the "what," "why," "who" and "how" of each operation. The "why" is particularly important—and the auditor must be patient and persistent until he is completely satisfied with the answer.

THE INTERNAL AUDITOR'S APPROACH

Let us assume that the internal auditor is making an audit of an operating department for the first time. First he must sit down with the department head and explain the purpose of his audit. He explains that he is *not* there to pose as an expert in the function of that department. He is there to examine, appraise and report on the controls which govern the work of the department. He is there to learn of any apparent deficiencies or failures of control or other relationships between that department and the other departments of the company. (In this area, he is almost certain to arouse interest, since failings of this sort are very common.)

The next step is to acquire general familiarity with the basic operations and objectives of the department—since he must know in general what the job of the department is in order to examine and appraise the effectiveness of the control structure which is set up to fulfill that responsibility.

Some operating department heads like to throw an aura of mystery about their work, implying that one can begin to understand their work and problems only after years of specific experience. Very often such individuals like to talk—and from their talking, and with a few judicious questions, the auditor can develop enough information to provide the essential background. The auditor must explain, of course, that he is not concerned with becoming an operating expert—he merely wants a general picture of policies, procedures and problems. The executive who gives a straightforward description is fortunately more common, and the auditor need do little but listen and guide the conversation with an occasional question.

The important objective in this familiarization is to learn how the operations are viewed by the man who runs them. Even when the auditor has a fair knowledge of the operations himself, he should not volunteer it—since this will defeat the objective of learning from the operating executive.

In these conversations with the department head, it is important to learn the means by which that executive decides how well the department has performed—both in its individual units and as a whole. Some interesting and occasionally surprising answers will be given when the question is asked "How do you decide how good a job John Brown is doing?" In this particular question, the auditor is trying to develop the standards of performances that the department applies to its work.

THE OPERATIONAL AUDIT

The general plan of making an operational audit has been well described in the Research Committee Report on "Internal Audit and Control of a Traffic Department." Rather than to paraphrase, I quote directly from the report:

APPROACH TO AN OPERATIONAL AUDIT

Viewed in its broad aspects, the approach and general plan of an audit of an operating department is the same as an audit of a financial department. The steps by the internal auditor may be summarized as: (1) familiarization, (2) verification, (3) evaluation and (4) reporting.

Familiarization. In the first step the internal auditor, through discussions with departmental personnel, acquaints himself with the operating objectives and problems of the department. He then proceeds to learn how these objectives and problems are met and controlled by departmental management.

First comes the organization structure. Here the auditor is interested in learning the assignments of authority and responsibility and the interrelationships with other departments and between subordinate groups within the department.

Next comes the review of the procedures which govern the work of the department. The concern here is to learn the degree to which procedures are definite and complete, so that no "twilight" zones will lead to oversight or conflict of responsibility.

Written procedures are a necessity in practically all operations. Through them, individual employees know what they have to do—and those directly responsible and others are informed as to the scope of responsibility and the methods of operation. Written procedures establish standards of performance. When a violation occurs, it provides a definite signal that further investigation should be made. Something may be unusual about a particular transaction, or the procedure itself may be incomplete or incorrect.

Verification. Having familiarized himself with the general responsibilities of the operating department and the manner in which the department controls its operations, the internal auditor then proceeds to verification. In this portion of his work, the objective is to learn whether the actual operations and assignment of responsibility follow the plans prescribed by departmental management.

Verification requires that a selected sample of transactions or a selected area of work be examined in detail. The original size of the sample or the area will

depend on the judgment of the auditor and will usually be comparatively small. If the original tests indicate that further sampling is desirable to reach a conclusion, then such sampling follows:

In verification, the objective of the internal auditor is fact-finding. He is concerned with learning:

1. Do the organization structure and assignment of responsibility follow the control plans of departmental management?
2. Are procedures prescribed by management being followed?
3. Are the internal controls established by departmental management being enforced?
4. How are the internal controls co-ordinated with other operating departments?

Evaluation. Having determined what the plans are and how effectively they are being followed, the internal auditor then proceeds to the work of evaluation and appraisal. In this phase, his problems will be:

1. Do departmental controls conform with company policy? If not, what appears to be the reason?
2. If there are numerous deviations from established procedure, does the reason lie with the procedures or with other factors?
3. Do departmental controls automatically reveal to management the out-of-the-ordinary situation that should have attention?
4. Do departmental controls appear effective in operation?

Reporting. In financial areas, a definite opinion can usually be given as to effectiveness of controls—since ineffective controls will lead to questionable operations or incorrect results.

In operating departments, such opinions are often not possible. To quote from one auditor:

"Operational audits have been most successful when the auditor was not in the position of matching his opinion as to the effectiveness of a control or the need for an additional control with the various levels of management responsible for such control. Normally such a position can be avoided by providing, through normal auditing techniques, satisfactory evidence that a control is not effective and should be corrected or that an uncontrolled area should be placed under control. But it is absolutely essential that evidence be developed and produced in support of the auditor's position."

Following this thought, it becomes evident that the report is primarily a pointing out to departmental and general management how controls are operating—in theory and in practice, both within the operating department and in relation to other departments.

An essential of reporting is that the report be discussed and reviewed in complete detail with the operating department before submission in final form. This review will insure that there is agreement in factual matters and gives the operating department a chance to suggest the course of corrective action that may be indicated by the facts of the report.

DISTINCTION BETWEEN OPERATIONAL AUDITING AND ORGANIZATION AND METHODS WORK

Because the internal auditor's work in operating departments requires that he become familiar with the problems and the operations of these departments, there is apt to be some confusion as to the responsibility of the

internal auditor and of those engaged in organization and methods or operations research work. In actuality, there is no reason for confusion or conflict.

Organization and methods and operations research personnel study the work of an operating department with an objective of developing procedures, reports and other routines and controls to govern the day-to-day work of the department. The internal auditor then appraises the operation of the controls which these other groups have established. He will point out strengths and weaknesses—but he does not establish the controls. That is not his job. This separation of responsibility is expressed in the Statement of Responsibilities of the Internal Auditor—"internal auditors should not develop procedures, prepare records, or engage in any other activity which they normally would be expected to review and appraise."

CONVINCING MANAGEMENT OF THE BENEFITS OF OPERATIONAL AUDITING

I wish it were possible to describe some sort of sales campaign by which management could be convinced of the benefits of operational auditing. Unfortunately, this cannot be done, since managements and auditing departments are composed of individuals—with individual talents, ideas and preferences. For this reason, the selling job is an individual one in every situation.

As far as the internal auditor is concerned, I can offer certain suggestions:

1. The internal auditor should prepare himself, through study of his company and of internal auditing material, to do the broad job that is required in operational auditing.
2. When opportunity offers, the internal auditor should bring to management's attention what other companies have done in the operational auditing field. Institute publications and similar material are one way of doing this.
3. The internal auditor should do a broad and outstanding job in the field to which he is presently assigned. Then he is apt to find that his field of effort will be broadened. This approach is summed up in a little saying that my mother was fond of, "The reward of work well done is more work."

In talking of mangement, I mean executive management and not the managers of operating departments. It is essential that the auditor come into operating departments with the wholehearted backing of executive management. If he does not have this, he had better not start. Once in the departments, he should be able to demonstrate to both departmental and executive management that he can perform a constructive service. This

usually is the case—I have no personal knowledge of any situation where there has been a retreat from an operational auditing program once it has been established.

5. A STATEMENT OF RESPONSIBILITIES OF THE INTERNAL AUDITOR*

The objectives and scope of internal auditing are succinctly outlined in the following statement:

NATURE OF INTERNAL AUDITING

Internal auditing is an independent appraisal activity within an organization for the review of accounting, financial and other operations as a basis for service to management. It is a managerial control, which functions by measuring and evaluating the effectiveness of other controls.

OBJECTIVE AND SCOPE OF INTERNAL AUDITING

The over-all objective of internal auditing is to assist all members of management in the effective discharge of their responsibilities, by furnishing them with objective analyses, appraisals, recommendations and pertinent comments concerning the activities reviewed. The internal auditor therefore should be concerned with any phase of business activity wherein he can be of service to management. The attainment of this over-all objective of service to management should involve such activities as:

Reviewing and appraising the soundness, adequacy and application of accounting, financial and operating controls.

Ascertaining the extent of compliance with established policies, plans and procedures.

Ascertaining the extent to which company assets are accounted for, and safeguarded from losses of all kinds.

Ascertaining the reliability of accounting and other data developed within the organization.

Appraising the quality of performance in carrying out assigned responsibilities.

* From the Institute of Internal Auditors, 1957. Reprinted by permission.

AUTHORITY AND RESPONSIBILITY

Internal auditing is a staff function rather than a line function. Therefore the internal auditor does not exercise direct authority over other persons in the organization, whose work he reviews.

The internal auditor should be free to review and appraise policies, plans, procedures, and records; but his review and appraisal does not in any way relieve other persons in the organization of the responsibilities assigned to them.

INDEPENDENCE

Independence is essential to the effectiveness of the internal auditing program. This independence has two major aspects.

1. The organizational status of the internal auditor and the support accorded to him by management are major determinants of the range and value of the services which management will obtain from the internal auditing function. The head of the internal auditing department, therefore, should be responsible to an officer of sufficient rank in the organization as will assure a broad scope of activities, and adequate consideration of and effective action on the findings or recommendations made by him.

2. Since complete objectivity is essential to the audit function, internal auditors should not develop and install procedures, prepare records, or engage in any other activity which they normally would be expected to review and appraise.

6. WHAT IS A CONTROLLER?*

The duties and responsibilities of a controller are listed in the following statement issued by the Controllers Institute of America.

The institute's concept of the function of controllership is:

1. To establish, co-ordinate and administer, as an integral part of management, an adequate plan for the control of operations. Such a plan would provide, to the extent required in the business, profit planning, programs for capital investing and for financing, sales forecasts, expense

* From *Controllers Institute of America,* 1959, 12 pp. Reprinted by permission of the Controllers Institute of America.

budgets and cost standards, together with the necessary procedures to effectuate the plan.

2. To compare performance with operating plans and standards, and to report and interpret the results of operations to all levels of management and to the owners of the business. This function includes the formulation and administration of accounting policy and the compilation of statistical records and special reports as required.

3. To consult with all segments of management responsible for policy or action concerning any phase of the operation of the business as it relates to the attainment of objectives and the effectiveness of policies, organization structure and procedures.

4. To administer tax policies and procedures.

5. To supervise or co-ordinate the preparation of reports to governmental agencies.

6. To assure fiscal protection for the assets of the business through adequate internal control and proper insurance coverage.

7. To continuously appraise economic and social forces, and government influences, and interpret their effect upon the business.

7. INTERNAL CONTROL*

A special report of the Committee on Auditing Procedures of the American Institute of Accountants (now known as the American Institute of Certified Public Accountants) discusses the elements of a co-ordinated system and its importance to management and the independent public accountant. Included in the report is a definition of internal control, the essentials of which follow.

Internal control comprises the plan of organization and all of the co-ordinate methods and measures adopted within a business to safeguard its assets, check the accuracy and reliability of its accounting data, promote operational efficiency, and encourage adherence to prescribed managerial policies. This definition possibly is broader than the meaning sometimes attributed to the term. It recognizes that a "system" of internal control extends beyond those matters which relate directly to the functions of the accounting and financial departments. Such a system might include budgetary control, standard costs, periodic operating reports, statistical analyses

* Reprinted with permission from *Internal Control*, published in 1949 by the American Institute of Certified Public Accountants.

and the dissemination thereof, a training program designed to aid personnel in meeting their responsibilities, and an internal audit staff to provide additional assurance to management as to the adequacy of its outlined procedures and the extent to which they are being effectively carried out. It properly comprehends activities in other fields as, for example, time and motion studies which are of an engineering nature, and use of quality controls through a system of inspection which fundamentally is a production function.

What may be said to be the characteristics of a satisfactory system of internal control? Certainly, they would include

A plan of organization which provides appropriate segregation of functional responsibilities,

A system of authorization and record procedures adequate to provide reasonable accounting control over assets, liabilities, revenues and expenses,

Sound practices to be followed in performance of duties and functions of each of the organizational departments, and

A degree of quality of personnel commensurate with responsibilities.

These elements, as important as each is in its own right, are all so basic to proper internal control that serious deficiencies in any one normally would preclude successful operation of the system. For example, no plan of authorization and record procedures for accounting control may be considered adequate without personnel capable of performing the procedures designed to make such a system work, nor can one consider the practices followed in the performance of duties in the organizational departments sound unless there is departmental independence so that resonsibilities can be placed and interdepartmental controls enforced.

ORGANIZATIONAL INDEPENDENCE OF DEPARTMENTS

An important criterion as to the adequacy of any plan of organization is the extent to which it provides for organizational independence as between operating, custodian, and accounting (including internal auditing) departments. Organizational independence does not imply the erection of any barriers preventing frequent consultation between departments to devise means of smoothing the flow of work and increasing the over-all efficiency of operation. The work of all departments must be closely integrated and co-ordinated and, to that end, co-operation is essential. The basis for the separation rests on the premise that no department should control the accounting records relating to its own operations. It represents an extension at the departmental level of the oft-repeated principle that no

one person should control all phases of a transaction without the intervention of some other person or persons who afford a cross-check. Without such a separation, the accounting records may be so manipulated as to make the detection of errors and fraud exteremely difficult, if not impossible.

II

CONTROL AND THE ADMINISTRATOR

8. CONTROL MEANS ACTION

Arnold F. Emch*

The author asserts that the functions of planning and performance evaluation are not independent of organization. He relates controls to the specific responsibilities and activities of each executive position, which he calls functional control, thus making it an integral part of each executive's duties and not something which is done by a "controller." Control, thus envisaged, emphasizes the follow-through activities which result from an awareness of what is expected and what is accomplished.

In today's competitive economy there is a tremendous premium on initiative in management. Although intelligent policy making and planning are, as always, of decisive importance, top-level planners feel more dependent than ever on those "centers of initiative" down the line.

How does the concept of "control" fit into this picture, particularly with respect to the problem of initiative on the part of executives who are charged with the responsibility of getting things done? Is control a boon or a barrier to initiative? This question is widening a four-way split of executive opinion in industry as well as in governmental and nonprofit enterprise. One group is unqualifiedly for something or other they call "control"; a second group looks on the whole business with a jaundiced

* From *Harvard Business Review*, XXXII, 4 (1954), 92-98. Reprinted by permission of the *Harvard Business Review*.

eye; a third group finds itself uncomfortably in the middle with the feeling that there is something wrong with each of the extreme points of view; and a fourth group subscribes to the functional concept that will be presented in the following pages.

INEFFECTIVENESS AT THE TOP

The bewildering difference of opinion and practice in this area makes no sense at all until we remember that control—perhaps more than any other major management function—reflects the personalities and attitudes of those at the top. Let us see what some of these executives look like.

CAPTAIN QUEEG: EXCESSIVE CONTROL

At one extreme is the Captain Queeg type of *Caine Mutiny* fame, who insists on the letter of the law to such an extent that war can rage all around him while he is trying to find out who ate the quart of strawberries. From the standpoint of management, what was the matter with Captain Queeg? Two things—one psychological, the other methodological.

As Herman Wouk, the author of the book, painted him, Captain Queeg was fundamentally so insecure and suspicious that he had to know every last detail of what every last tar aboard the U.S.S. Caine was doing in order to protect himself and to assure himself that all policies, rules, and regulations of the Navy were observed down to the last minutia. What he forgot in this preoccupation with detail was (a) that he and his kind might lose the war, and (b) that he was stifling all initiative, interest, and enthusiasm on the part of his men. In short, he was, through his interpretation of control, forgetting the strategic objectives of the war and, at the same time, creating a serious morale problem in his crew.

The situation on Captain Queeg's ship was a typical example of the stultifying effect of rigidly confining strait-jacket "control procedures" on the imagination and intellect of men. In the words of Keefer, one of the principals of the story, it was a situation in which "the work has been fragmentized by a few excellent brains at the top, on the assumption that near-morons will be responsible for each fragment."

In business this type of control does not of course bring about mutiny in the usual sense. What it does instead is to create (a) an undertone of frustration and a sense of futility; (b) a pattern of alibis, truth-slantings, and downright dishonesty; (c) outright conflicts among executives, due to exercise of control by some who have no corresponding responsibility for action; (d) a gradual diminution of the use of initiative and judgment to the point where executives are absorbed in clerical detail and meticulous line-by-line paper-pushing practices; and (e) an increase in executive

turnover as a result of the more intelligent and courageous personnel looking elsewhere for a more favorable condition for the exercise of their real talents.

I have cited a fictitious character as an example; but actually, in business, government, and nonprofit enterprises, there are literally hundreds of Captain Queeg's counterparts. These men build up a system of control that in the end defeats the purposes for which it was originally intended. The paper, the personnel, the money, and the time expended on forms, reports, manuals, bulletins, and statistics in support of these misbegotten control systems are enough to stagger the most eager imagination. As pointed out in the ACME *Reporter* (bulletin of the Association of Consulting Management Engineers):

> It often develops to the point where mere following of procedures becomes more important than carrying out policies and striving toward objectives. The result is a creeping, self-propagating bureaucracy.

Do these burdensome control systems ever accomplish their original purpose? Do they not have some merit? All I can say is that in my experience as a management consultant to different kinds of businesses over the past 20 years, I have never seen such a setup or such an operation pay off.

Quite the contrary! I have found all the shortcomings of the usual dictatorial and all-embracing regime, including the inevitably weak, insecure, or overambitious executive at the top; mountains of forms, reports, manuals, directives, and interpretative bulletins which nobody reads or which, if they are read, require special staffs to pore over them to keep executives abreast; bad morale in the second and third layers of management; and, believe it or not, usually poor planning and lack of significant management information when and where it is needed—the very things you would think *could* be accomplished by these immense, involved, and demanding systems of control.

WILL ROGERS: INSUFFICIENT CONTROL

Now let us look at Captain Queeg's opposite, the executive who is pretty sure of himself and who inclines to be a "good egg" with democratic impulses. He does not like control and he does not want any part of it. It is repugnant to him. His philosophy of management is to shove his men off the dock and make them swim. That is the way they can learn best. "Sure, they'll make mistakes," he says with a confident, genial grin; "that's good for them; that's the way they'll learn the facts of life." His is the freedom-of-enterprise point of view in the extreme.

But despite his rodeo-bronco-swim-for-your-life approach to management, this Will Rogers sooner or later will want to know where his business is going and how well it is doing on its way. Instead of having a "controller" in any usual sense—this of course he would not tolerate—he sets out

to find himself a bright, young, likable, willing fellow, and without much ado appoints him "assistant to the president."

There are all kinds of things that Mr. Rogers will want to know—usually pronto—and no ready information will be available to supply this need. So he will call in his assistant, throw him the ball without concern or premeditation, and let it go at that.

It takes no genius to figure out what this apparently simple practice will lead to. The assistant is eager, able, and willing; and he goes about these repeated assignments with energy and dispatch. It does not take long for him to realize that he does not have certain information at hand. He begins to build up a little system all his own. His desk drawers and filing cases fill up with special data. He takes an increasing interest in the budget and begins to question department heads as to the justification of certain items. He even has misgivings on just how he ought to go about getting some of the information that he knows he will eventually need.

But the rest of the staff soon comes to realize that, although the newcomer is only the assistant to the president whereas they are vice presidents or managers, this young fellow has the ear of the boss and is beginning to analyze things and increasingly make judgments for the president. Perhaps they had better play ball with the young man, they think, if they are to stay in the good graces of Mr. Rogers. And so it goes. A roundabout way of control is devised—never direct, never through channels, never through organization objectives, or policies, or clear-cut statements of basic procedure. Nobody quite knows any more what he should or should not do, but everyone is quite certain that "cooperation" with the assistant is the order of the day.

FUNCTIONAL CONTROL

Now what is the matter with all this? What is the matter with Captain Queeg's or Mr. Rogers' approach to control? It boils down to this: Each approach shows a complete lack of understanding or appreciation of what control is trying to accomplish in an enterprise, and of how to get executives to assume and carry out effectively their proper responsibilities. Put very simply, there can be too much control and there can be too little control; in both cases there is a misunderstanding or a corruption of control in the necessary and sound sense.

Let us look at it in another way. What is the problem we are dealing with when we talk of "control"? Actually it is simple: We have a job to do—a line of services or products to make and sell at a profit. There are a number of persons involved in the doing of that job. Hence we organize ourselves in some fashion so that each one of us has specific, assigned tasks, all more or less related to one another. And we try to see that each key

individual has a clear understanding of his functions, of his lines of authority downward, and of his line of responsibility upward.

But if we should go only this far, we would not go far enough. We must also determine what each of these individuals needs in the way of facts and figures in order to perform his job effectively. This, then, is the problem of control: to match the responsibilities of every key position with the management information necessary for the effective and efficient execution of those responsibilities. Control itself can be defined as the making of decisions and taking of actions required by the responsibilities of each position, i.e., the proper performance of each executive according to the requirements of his position.

Now, some readers may object to this concept on the ground that it does not even mention the familiar rudiments of control, traditionally conceived. You may be prompted to say: "Control means making sure that actual results conform to desired results, and this involves three basic functions: (a) setting standards of satisfactory performance; (b) checking results to see how they compare with the standards; and (c) taking corrective action where actual results do not meet the standards."

I have no quarrel with this concept, except that these functions ought to be, and in fact must be, built *into* the organization structure as part and parcel of the responsibilities and authorities of every key position. They should not be segregated and put on a list of functions under the heading "control."

This brings us to the basic law of most control systems as well as of most plans of organization. Control and organization have generally been treated independently of each other, thus missing the point of how the organization is to work in practice, or of what the executives are trying to control in the operations. Actually organization and control are inseparable when there is effective management; they cannot function properly without each other.

How many times have you pored over an organization plan only to find yourself saying: "In general I think it is good, but how do I do this particular job; how can I carry out the responsibilities entrusted to me?" The answer here to a very large extent is in the informational and control system that is established. What are the "management dials" necessary for you to do your job? What are the significant management factors you should have before you in order to make executive judgment, and what is it you do when certain things take place? Do you know what you should do, and why, and what are the probable consequences of your decisions?

This is the problem of control in every executive position in the enterprise, up and down the various levels in the organization. In short, the answer to the effective operation of the plan of organization is primarily through a system of control which is part and parcel of it.

An effective system of control, in turn, depends on the plan of organization. If you tried to look at your control problem without considering the plan of organization, you would soon find yourself asking, "Who gives me this information? Why do I get it? What do I do with it?" Obviously you could not answer until you knew who was responsible for what in the scheme of things—in other words, the organization again.

Relating control to the specific responsibilities and authorities of each executive position is what I have chosen to call "functional control." In this sense control is an integral element of every function in the organization, and every function will then be truly under control.

RULES AND GUIDES

If management accepts the concept of control just described, it will find that a number of challenging corollaries follow in consequence.

CONTROLLERS DON'T CONTROL

First, the new concept of control will require some reorientation in the traditional or prevailing practices and tendencies of controllers or control offices. It will require recognition of the fact that a controller does not actually control, and that any effort on his part to take over the function of control from the operating personnel will lead inevitably to the abuses and misunderstandings I have already mentioned.

The word "control" itself has no doubt led to the misconception that the control function of an enterprise is a highly centralized activity in the office of a controller; that management reports, statistics, and information generally are not only collected by the controller but are also specifically for his use; and, finally, that he has the authority to bring about executive actions throughout the organization without assuming corresponding responsibility for those actions.

Nothing of course could be farther from the application of effective control in a well-managed enterprise. Although the controller is or should be a major executive at the same level as the other divisional executives of an enterprise, and hence is or should be a part of the top-management team, it should be noted that, apart from his usual departmental activities such as keeping records, paying bills, receiving cash, preparing invoices, maintaining the office and routine accounting, he has no direct operating responsibilities.

In fact, the more important and delicate tasks the controller must perform have to do with advising the president and other executives on the broad, over-all picture of the enterprise; co-ordinating basic plans and budgets; preparing and issuing special control reports; and standardizing

methods of accounting and other procedures. Note the predominantly *informational* character of each of these responsibilities.

PLANNING IS THE BASIS

The misuse of the control function has far-reaching consequences in the planning and budgeting process. The budget is a primary means of assuring that actions conform to basic plans. It is a device for measuring the actions taken and for determining the actions required. But it does not, *of itself*, control.

Almost as important as the budget itself is the planning of the operation that is finally translated into the budget. In the planning phase, as we all know, actions are proposed, opposing points of view are resolved, and a consistent course of action is set. Conditions expected are appraised, and proposed actions to meet these conditions are devised. To the extent that planning determines the actions that need to be taken and stimulates thinking ahead about those actions, it is a most effective basis for control—but, again, it is not control itself.

Thus, plans and budgets together provide a picture, in common related terms, of what is intended and expected and the means by which the goals are to be achieved. They provide a means for reporting back the progress made against the goals, and a general framework for new decisions and actions in an integrated pattern of development. A good example of a planning and budgeting basis for control is provided by the postwar experience of a company that was producing large, expensive precision equipment:

The management of this company decided to prepare a report called a "production forecast." It was based on an estimate of sales and was adjusted for both engineering and manufacturing loads. When finally approved by the executive committee it became an 18-month plan which was to be adjusted periodically in accordance with manufacturing lead times and in terms of what the company expected to make (the rate and volume of production).

The plan was eminently successful and, even to this day, is eagerly awaited each quarter by all operating executives, since it has become the basis for many decisions throughout the company. From it can be calculated such figures as number of direct workers required, number of workers needed in service areas (payroll and accounting), adjustments in the level of inventory, and adjustments in purchasing loads and selling programs.

Prior to adoption of this plan the company was continually faced with unexplained increases in inventories, with serious imbalances between number of production workers and actual requirements, and with the

sales department and the manufacturing department working at cross purposes. For instance, it was found that the sales department was selling custom designs for delivery at times when the manufacturing department was unable to produce even its normal load of standard lines.

Properly conceived and used, such plans and budgets can become important elements in implementing effective control. Rather than impeding judgment, they should contribute to initiative in avoiding undesirable conditions and in meeting such conditions when they do arise.

ACTION IS THE ESSENCE

Control is being exercised when the operations of the enterprise are guided within the plans adopted, are held in line in the face of varying conditions, or are returned to an in-line state after deviations are located. Note that action is implied in each case. This is important. In a very real sense, control means action—action to correct a condition found to be in error, or action to prevent such a condition from arising—and is never achieved without having action as an essential step.

Thus, in the case of the precision equipment company whose planning procedure was just described, control was actually achieved through a series of specific steps taken by the various department heads acting in response to the production forecast:

(1) Idle workers, approximating 10% of the total number, were reassigned to other areas.

(2) Personnel requirements in all service and staff areas were recalculated.

(3) Personnel were added in the sales area in order to step up sales effort.

(4) Order points and ordering quantities on two major product lines were reset.

(5) Deliveries on open orders with vendors were extended.

(6) For the near future, purchasing requirements were frozen at minimum levels.

(7) Sufficient cause was found to re-examine the company's entire inventory, which resulted in scrapping $500,000 in materials and using materials on hand in lieu of ordering new materials.

Note that management had first made a co-operative planning and budgeting effort; then came control in the form of action.

DELEGATION IS THE KEY

But control action can be taken only by the individual executives who hold delegated responsibility and authority for the operations affected. Certainly it makes little sense to assign someone the "responsibility" for a specific operation; set the achievement of certain results as a goal; and

then, through a series of denials, restrictions, limitations, specifications, and decisions, allow him no initiative.

In such instances, the wise, loyal, and experienced executive will try to conform and to achieve the desired results. If he succeeds, it will probably be because of his own ingenuity, patience, flexibility, and doggedness, rather than because of any superimposed decisions coming from above. If he fails, however, there is a real question of accountability, since many of the decisions and actions will have been precipitated by others not directly responsible for the operation. This of course is a perfect setting for alibis and for passing the buck when the going gets rough; someone has to be the scapegoat for miscalculations or poor performance.

To sum up, merely discovering out-of-line conditions, or having detailed information about a situation, does not achieve control. Control is exercised by taking action, and action must be taken within the authority delegated. And just as no person can be said to control directly the activities assigned to another's jurisdiction, so the only person who can directly control activities is the one directly responsible for them. This is fundamental to the healthy and successful operation of any enterprise; at the same time it is probably one of the least observed principles of management. There are a great many more instances of its violation than there are of its wholehearted acceptance and practice.

INFORMATION IS THE GUIDE

Now we can see more clearly where information, such as provided by the controller, fits into the picture. Many enterprises have grown beyond the size where they can be managed by decisions arrived at through direct observation alone. So there must be control; and control requires a system of information tailored to the specific management needs of every key executive—information that is *timely* and *adequate.*

Let us take the timeliness factor first. While information *as such* does not control, it is needed by executives as a guide to actions which do control. Because they overlook this, controllers frequently miss the mark in being of real service to operating personnel. In general, they submit too many historical reports which merely relate what has taken place. Management would rather have approximate information that is prompt than highly accurate information after it is too late to be of value in decision making.

Turning now to the second factor, what is the criterion of "adequate" information? What *kind* of information is adequate, and how *much?* Frequently controllers solve this problem by giving the line executives everything there is to know—by virtually swamping them in facts and figures. But the effect of too much is likely to be almost as bad as too little or too late.

A system of control should require no more than is absolutely necessary in the way of reports, data, and statistics. The determination of what is "necessary" should conform to this simple dictum: In accord with your responsibilities and authority, can you or should you do anything about the information that is presented to you and, if so, what? This is the final criterion of management or control information. If you can do nothing about the material that is presented, then it is purely informative and not strictly necessary for you for management purposes.

Every key position in an enterprise is or should be related to some objective or set of objectives. These, in turn, should be translated into specific goals for specific calendar periods. The executive in charge of any operation or department, in order to achieve these specific goals within certain time limits, should have before him specific performance data—"management dials"—so he can know how well his operation is progressing and, if significantly out of line, what he individually must do to correct the situation.

CONCLUSION

What is needed is an understanding that the functions of planning and performance evaluation are part and parcel of the entire organization, and must therefore be distributed to each and every appropriate level of responsibility—instead of being concentrated in a highly centralized office that usually carries the name of "the controller." Every key executive, in fulfilling his responsibilities, is or should be his own "controller." In this sense, control can be as much an energizing as a steering function. So conceived it should no longer be a barrier but a tremendous boon to initiative.

9. SKILLS OF AN EFFECTIVE ADMINISTRATOR

Robert L. Katz*

Mr. Robert L. Katz states that effective administration depends on three basic personal skills: technical, human, and conceptual. He shows the differing degrees in which these skills are important in various levels of administration and discusses ways in which these skills may be further developed and improved.

* From *Harvard Business Review*, XXXIII, 1 (1955), 33-42. Reprinted by permission of the *Harvard Business Review*.

Although the selection and training of good administrators is widely recognized as one of American industry's most pressing problems, there is surprisingly little agreement among executives or educators on what makes a good administrator. The executive development programs of some of the nation's leading corporations and colleges reflect a tremendous variation in objectives.

At the root of this difference is industry's search for the traits or attributes which will objectively identify the "ideal executive" who is equipped to cope effectively with any problem in any organization.

Yet this quest for the executive stereotype has become so intense that many companies, in concentrating on certain specific traits or qualities, stand in danger of losing sight of their real concern: *what a man can accomplish.*

It is the purpose of this article to suggest what may be a more useful approach to the selection and development of administrators. This approach is based not on what good executives *are* (their innate traits and characteristics), but rather on what they *do* (the kinds of skills which they exhibit in carrying out their jobs effectively). As used here, a *skill* implies an ability which can be developed, not necessarily inborn, and which is manifested in performance, not merely in potential. So the principal criterion of skillfulness must be effective action under varying conditions.

This approach suggests that effective administration rests on *three basic developable skills* which obviate the need for identifying specific traits and which may provide a useful way of looking at and understanding the administrative process.

THREE-SKILL APPROACH

It is assumed here that an administrator is one who (a) directs the activities of other persons and (b) undertakes the responsibility for achieving certain objectives through these efforts. Within this definition, successful administration appears to rest on three basic skills, which we will call *technical, human,* and *conceptual.* It would be unrealistic to assert that these skills are not interrelated, yet there may be real merit in examining each one separately, and in developing it independently.

TECHNICAL SKILL

As used here, technical skill implies an understanding of, and proficiency in, a specific kind of activity, particularly one involving methods, processes, procedures, or techniques. It is relatively easy for us to visualize the technical skill of the surgeon, the musician, the accountant, or the engineer when each is performing his own special function. Technical

skill involves specialized knowledge, analytical ability within that specialty, and facility in the use of the tools and techniques of the specific discipline.

Of the three skills described in this article, technical skill is perhaps the most familiar because it is the most concrete, and because, in our age of specialization, it is the skill required of the greatest number of people. Most of our vocational and on-the-job training programs are largely concerned with developing this specialized technical skill.

HUMAN SKILL

As used here, human skill is the executive's ability to work effectively as a group member and to build cooperative effort within the team he leads. As *technical* skill is primarily concerned with working with "things" (processes or physical objects), so *human* skill is primarily concerned with working with people. This skill is demonstrated in the way the individual perceives (and recognizes the perceptions of) his superiors, equals, and subordinates, and in the way he behaves subsequently.

The person with highly developed human skill is aware of his own attitudes, assumptions, and beliefs about other individuals and groups; he is able to see the usefulness and limitations of these feelings. By accepting the existence of viewpoints, perceptions, and beliefs which are different from his own, he is skillful in understanding what others really mean by their words and behavior. He is equally skillful in communicating to others, in their own contexts, what he means by *his* behavior.

Such a person works to create an atmosphere of approval and security in which subordinates feel free to express themselves without fear of censure or ridicule, by encouraging them to participate in the planning and carrying out of those things which directly affect them. He is sufficiently sensitive to the needs and motivations of others in his organization so that he can judge the possible reactions to, and outcomes of various courses of action he may undertake. Having this sensitivity, he is able and willing to *act* in a way which takes these perceptions by others into account.

Real skill in working with others must become a natural, continuous activity, since it involves sensitivity not only at times of decision making but also in the day-by-day behavior of the individual. Human skill cannot be a "sometime thing." Techniques cannot be randomly applied, nor can personality traits be put on or removed like an overcoat. Because everything which an executive says and does (or leaves unsaid or undone) has an effect on his associates, his true self will, in time, show through. Thus, to be effective, this skill must be naturally developed and unconsciously, as well as consistently, demonstrated in the individual's every action. It must become an integral part of his whole being.

Because human skill is so vital a part of everything the administrator does, examples of inadequate human skill are easier to describe than are highly skillful performances.

CONCEPTUAL SKILL

As used here, conceptual skill involves the ability to see the enterprise as a whole; it includes recognizing how the various functions of the organization depend on one another, and how changes in any one part affect all the others; and it extends to visualizing the relationship of the individual business to the industry, the community, and the political, social, and economic forces of the nation as a whole. Recognizing these relationships and perceiving the significant elements in any situation, the administrator should then be able to act in a way which advances the over-all welfare of the total organization.

Hence, the success of any decision depends on the conceptual skill of the people who make the decision and those who put it into action. When, for example, an important change in marketing policy is made, it is critical that the effects on production, control, finance, research, and the people involved be considered. And it remains critical right down to the last executive who must implement the new policy. If each executive recognizes the over-all relationships and significance of the change, he is almost certain to be more effective in administering it. Consequently the chances for succeeding are greatly increased.

Not only does the effective co-ordination of the various parts of the business depend on the conceptual skill of the administrators involved, but so also does the whole future direction and tone of the organization. The attitudes of a top executive color the whole character of the organization's response and determine the "corporate personality" which distinguishes one company's ways of doing business from another's. These attitudes are a reflection of the administrator's conceptual skill (referred to by some as his "creative ability")—the way he perceives and responds to the direction in which the business should grow, company objectives and policies, and stockholders' and employees' interests.

Conceptual skill, as defined above, is what Chester I. Barnard, former president of the New Jersey Bell Telephone Company, implies when he says: ". . . the essential aspect of the [executive] process is the sensing of the organization as a whole and the total situation relevant to it."[1]

Because a company's over-all success is dependent on its executives' conceptual skill in establishing and carrying out policy decisions, this skill is the unifying, co-ordinating ingredient of the administrative process, and of undeniable over-all importance.

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[1] *Functions of the Executive* (Cambridge, Harvard University Press, 1948), p. 235.

RELATIVE IMPORTANCE

We may notice that, in a very real sense, conceptual skill embodies consideration of both the technical and human aspects of the organization. Yet the concept of *skill,* as an ability to translate knowledge into action, should enable one to distinguish between the three skills of performing the technical activities (technical skill), understanding and motivating individuals and groups (human skill), and co-ordinating and integrating all the activities and interests of the organization toward a common objective (conceptual skill).

This separation of effective administration into three basic skills is useful primarily for purposes of analysis. In practice, these skills are so closely interrelated that it is difficult to determine where one ends and another begins. However, just because the skills are interrelated does not imply that we cannot get some value from looking at them separately, or by varying their emphasis. Although all three are of importance at every level of administration, the technical, human, and conceptual skills of the administrator vary in relative importance at difference levels of responsibility.

AT LOWER LEVELS

Technical skill is responsible for many of the great advances of modern industry. It is indispensable to efficient operation. Yet it has greatest importance at the lower levels of administration. As the administrator moves further and further from the actual physical operation, this need for technical skill becomes less important, provided he has skilled subordinates and can help them solve their own problems. At the top, technical skill may be almost nonexistent, and the executive may still be able to perform effectively if his human and conceptual skills are highly developed. For example:

> In one large capital goods producing company, the controller was called on to replace the manufacturing vice president who had been stricken suddenly with a severe illness. The controller had no previous production experience, but he had been with the company for more than 20 years and knew many of the key production personnel intimately. By setting up an advisory staff, and by delegating an unusual amount of authority to his department heads, he was able to devote himself to co-ordination of the various functions. By so doing, he produced a highly efficient team. The results were lower costs, greater productivity, and higher morale than the production division had ever before experienced. Management had gambled that this man's ability to work with people was more important than his lack of a technical production background, and the gamble paid off.

Other examples are evident all around us. We are all familiar with those "professional managers" who are becoming the prototypes of our modern executive world. These men shift with great ease, and with no apparent

loss in effectiveness, from one industry to another. Their human and conceptual skills seem to make up for their unfamiliarity with the new job's technical aspects.

AT EVERY LEVEL

Human skill, the ability to work with others, is essential to effective administration at every level. One recent research study has shown that human skill is of paramount importance at the foreman level, pointing out that the chief function of the foreman as an administrator is to attain collaboration of people in the work group. Another study reinforces this finding and extends it to the middle-management group, adding that the administrator should be primarily concerned with facilitating communication in the organization. And still another study, concerned primarily with top management, underscores the need for self-awareness and sensitivity to human relationships by executives at that level. These findings would tend to indicate that human skill is of great importance at every administrative level, but notice the difference in emphasis.

Human skill seems to be most important at lower levels, where the number of direct contacts between administrators and subordinates is greatest. As we go higher and higher in the administrative echelons, the number and frequency of these personal contacts decrease, and the need for human skill becomes proportionately, although probably not absolutely, less. At the same time, conceptual skill becomes increasingly more important with the need for policy decisions and broad-scale action. The human skill of dealing with individuals then becomes subordinate to the conceptual skill of integrating group interests and activities into a co-ordinated whole.

In fact, a recent research study by Professor Chris Argyris of Yale University has given us the example of an extremely effective plant manager who, although possessing little human skill as defined here, was nonetheless very successful:

> This manager, the head of a largely autonomous division, made his supervisors, through the effects of his strong personality and the "pressure" he applied, highly dependent on him for most of their "rewards, penalties, authority, perpetuation, communication, and identification."
>
> As a result, the supervisors spent much of their time competing with one another for the manager's favor. They told him only the things they thought he wanted to hear, and spent much time trying to find out his desires. They depended on him to set their objectives and to show them how to reach them. Because the manager was inconsistent and unpredictable in his behavior, the supervisors were insecure and continually engaged in interdepartmental squabbles which they tried to keep hidden from the manager.
>
> Clearly, human skill as defined here, was lacking. Yet, by the evaluation of his superiors and by his results in increasing efficiency and raising profits and

morale, this manager was exceedingly effective. Professor Argyris suggests that employees in modern industrial organizations tend to have a "built-in" sense of dependence on superiors which capable and alert men can turn to advantage.[2]

In the context of the three-skill approach, it seems that this manager was able to capitalize on this dependence because he recognized the interrelationships of all the activities under his control, identified himself with the organization, and sublimated the individual interests of his subordinates to *his* (the organization's) interest, set his goals realistically, and showed his subordinates how to reach these goals. This would seem to be an excellent example of a situation in which strong conceptual skill more than compensated for a lack of human skill.

AT THE TOP LEVEL

Conceptual skill, as indicated in the preceding sections, becomes increasingly critical in more responsible executive positions where its effects are maximized and most easily observed. In fact, recent research findings lead to the conclusion that at the top level of administration this conceptual skill becomes the most important ability of all. As Herman W. Steinkraus, president of Bridgeport Brass Company said:

"One of the important lessons which I learned on this job [the presidency] is the importance of co-ordinating the various departments into an effective team, and, secondly, to recognize the shifting emphasis from time to time of the relative importance of various departments to the business."[3]

It would appear, then, that at lower levels of administrative responsibility, the principal need is for technical and human skills. At higher levels, technical skill becomes relatively less important while the need for conceptual skill increases rapidly. At the top level of an organization, conceptual skill becomes the most important skill of all for successful administration. A chief executive may lack technical or human skills and still be effective if he has subordinates who have strong abilities in these directions. But if his conceptual skill is weak, the success of the whole organization may be jeopardized.

IMPLICATIONS FOR ACTION

This three-skill approach implies that significant benefits may result from redefining the objectives of executive development programs, from reconsidering the placement of executives in organizations, and from revising procedures for testing and selecting prospective executives.

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[2] *Executive Leadership* (New York, Harper & Brothers, 1953); see also "Leadership Pattern in the Plant," HBR, January-February 1953, p. 63.

[3] "What Should a President Do?" *Dun's Review*, August 1951, p. 21.

EXECUTIVE DEVELOPMENT

Many executive development programs may be failing to achieve satisfactory results because of their inability to foster the growth of these administrative skills. Programs which concentrate on the mere imparting of information or the cultivation of a specific trait would seem to be largely unproductive in enhancing the administrative skills of candidates.

A strictly informative program was described to me recently by an officer and director of a large corporation who had been responsible for the executive development activities of his company, as follows:

> What we try to do is to get our promising young men together with some of our senior executives in regular meetings each month. Then we give the young fellows a chance to ask questions to let them find out about the company's history and how and why we've done things in the past.

It was not surprising that neither the senior executives nor the young men felt this program was improving their administrative abilities.

The futility of pursuing specific traits becomes apparent when we consider the responses of an administrator in a number of different situations. In coping with these varied conditions, he may appear to demonstrate one trait in one instance—e.g., dominance when dealing with subordinates—and the directly opposite trait under another set of circumstances—e.g., submissiveness when dealing with superiors. Yet in each instance he may be acting appropriately to achieve the best results. Which, then, can we identify as a desirable characteristic? Here is a further example of this dilemma:

> A Pacific Coast sales manager had a reputation for decisiveness and positive action. Yet when he was required to name an assistant to understudy his job from among several well-qualified subordinates, he deliberately avoided making a decision. His associates were quick to observe what appeared to be obvious indecisiveness.
>
> But after several months had passed, it became clear that the sales manager had very unobtrusively been giving the various salesmen opportunities to demonstrate their attitudes and feelings. As a result, he was able to identify strong sentiments for one man whose subsequent promotion was enthusiastically accepted by the entire group.

In this instance, the sales manager's skillful performance was improperly interpreted as "indecisiveness." Their concern with irrelevant traits led his associates to overlook the adequacy of his performance. Would it not have been more appropriate to conclude that his human skill in working with others enabled him to adapt effectively to the requirements of a new situation?

Cases such as these would indicate that it is more useful to judge an administrator on the results of his performance than on his apparent traits. Skills are easier to identify than are traits and are less likely to be misinterpreted. Furthermore, skills offer a more directly applicable frame of

reference for executive development, since any improvement in an administrator's skills must necessarily result in more effective performance.

Still another danger in many existing executive development programs lies in the unqualified enthusiasm with which some companies and colleges have embraced courses in "human relations." There would seem to be two inherent pitfalls here: (1) Human relations courses might only be imparting information or specific techniques, rather than developing the individual's human skill. (2) Even if individual development does take place, some companies, by placing all of their emphasis on human skill, may be completely overlooking the training requirements for top positions. They may run the risk of producing men with highly developed human skill who lack the conceptual ability to be effective top-level administrators.

It would appear important, then, that the training of a candidate for an administrative position be directed at the development of those skills which are most needed at the level of responsibility for which he is being considered.

EXECUTIVE PLACEMENT

This three-skill concept suggests immediate possibilities for the creating of management teams of individuals with complementary skills. For example, one medium-size midwestern distributing organization has as president a man of unusual conceptual ability but extremely limited human skill. However, he has two vice presidents with exceptional human skill. These three men make up an executive committee which has been outstandingly successful, the skills of each member making up for deficiencies of the others.

EXECUTIVE SELECTION

In trying to predetermine a prospective candidate's abilities on a job, much use is being made these days of various kinds of testing devices. Executives are being tested for everything from "decisiveness" to "conformity." These tests, as a recent article in *Fortune* points out, have achieved some highly questionable results when applied to performance on the job.[4] Would it not be much more productive to be concerned with skills of doing rather than with a number of traits which do not guarantee performance?

This three-skill approach makes trait testing unnecessary and substitutes for it procedures which examine a man's ability to cope with the actual problems and situations he will find on his job. These procedures, which

[4] William H. Whyte, Jr., "The Fallacies of 'Personality' Testing," *Fortune*, September 1954, p. 117.

indicate what a man can *do* in specific situations, are the same for selection and for measuring development. They will be described in the section on developing executive skills which follows.

This approach suggests that executives should *not* be chosen on the basis of their apparent possession of a number of behavior characteristics or traits, but on the basis of their possession of the requisite skills for the specific level of responsibility involved.

DEVELOPING THE SKILLS

For years many people have contended that leadership ability is inherent in certain chosen individuals. We talk of "born leaders," "born executives," "born salemen." It is undoubtedly true that certain people, naturally or innately, possess greater aptitude or ability in certain skills. But research in psychology and physiology would also indicate, first, that those having strong aptitudes and abilities can improve their skill through practice and training, and, secondly, that even those lacking the natural ability can improve their performance and effectiveness.

The *skill* conception of administration suggests that we may hope to improve our administrative effectiveness and to develop better administrators for the future. This skill conception implies *learning by doing.* Different people learn in different ways, but skills are developed through practice and through relating learning to one's own personal experience and background. If well done, training in these basic administrative skills should develop executive abilities more surely and more rapidly than through unorganized experience. What, then, are some of the ways in which this training can be conducted?

TECHNICAL SKILL

Development of technical skill has received great attention for many years by industry and educational institutions alike, and much progress has been made. Sound grounding in the principles, structures, and processes of the individual specialty, coupled with actual practice and experience during which the individual is watched and helped by a superior, appear to be most effective. In view of the vast amount of work which has been done in training people in the technical skills, it would seem unnecessary in this article to suggest more.

HUMAN SKILL

Human skill, however, has been much less understood, and only recently has systematic progress been made in developing it. Many different approaches to the development of human skill are being pursued by var-

ious universities and professional men today. These are rooted in such disciplines as psychology, sociology, and anthropology.

Some of these approaches find their application in "applied psychology," "human engineering," and a host of other manifestations requiring technical specialists to help the businessman with his human problems. As a practical matter, however, the executive must develop his own human skill, rather than lean on the advice of others. To be effective, he must develop his own personal point of view toward human activity, so that he will (a) recognize the feelings and sentiments which he brings to a situation; (b) have an attitude about his own experiences which will enable him to re-evaluate and learn from them; (c) develop ability in understanding what others by their actions and words (explicit or implicit) are trying to communicate to him; and (d) develop ability in successfully communicating his ideas and attitudes to others.

This human skill can be developed by some individuals without formalized training. Others can be individually aided by their immediate superiors as an integral part of the "coaching" process to be described later. This aid depends for effectiveness, obviously, on the extent to which the superior possesses the human skill.

For larger groups, the use of case problems coupled with impromptu role playing can be very effective. This training can be established on a formal or informal basis, but it requires a skilled instructor and organized sequence of activities. It affords as good an approximation to reality as can be provided on a continuing classroom basis and offers an opportunity for critical reflection not often found in actual practice. An important part of the procedure is the self-examination of the trainee's own concepts and values, which may enable him to develop more useful attitudes about himself and about others. With the change in attitude, hopefully, there may also come some active skill in dealing with human problems.

Human skill has also been tested in the classroom, within reasonable limits, by a series of analyses of detailed accounts of actual situations involving administrative action, together with a number of role-playing opportunities in which the individual is required to carry out the details of the action he has proposed. In this way an individual's understanding of the total situation and his own personal ability to do something about it can be evaluated.

On the job, there should be frequent opportunities for a superior to observe an individual's ability to work effectively with others. These may appear to be highly subjective evaluations and to depend for validity on the human skill of the rater. But does not every promotion, in the last analysis, depend on someone's subjective judgment? And should this subjectivity be berated, or should we make a greater effort to develop people within our organizations with the human skill to make such judgments effectively?

CONCEPTUAL SKILL

Conceptual skill, like human skill, has not been very widely understood. A number of methods have been tried to aid in developing this ability, with varying success. Some of the best results have always been achieved through the "coaching" of subordinates by superiors. This is no new idea. It implies that one of the key responsibilities of the executive is to help his subordinates to develop their administrative potentials. One way a superior can help "coach" his subordinate is by assigning a particular responsibility, and then responding with searching questions or opinions, rather than giving answers, whenever the subordinate seeks help.

Obviously, this is an ideal and wholly natural procedure for administrative training, and applies to the development of technical and human skill, as well as to that of conceptual skill. However, its success must necessarily rest on the abilities and willingness of the superior to help the subordinate.

Another excellent way to develop conceptual skill is through trading jobs, that is, by moving promising young men through different functions of the business but at the same level of responsibility. This gives the man the chance literally to "be in the other fellow's shoes."

Other possibilities include: special assignments, particularly the kind which involve interdepartmental problems; and management boards, such as the McCormick Multiple Management Plan, in which junior executives serve as advisers to top management on policy matters.

For larger groups, the kind of case-problems course described above, only using cases involving broad management policy and interdepartmental co-ordination, may be useful. Courses of this kind, often called "General Management" or "Business Policy," are becoming increasingly prevalent.

In the classroom, conceptual skill has also been evaluated with reasonable effectiveness by presenting a series of detailed descriptions of specific complex situations. In these the individual being tested is asked to set forth a course of action which responds to the underlying forces operating in each situation and which considers the implications of this action on the various functions and parts of the organization and its total environment.

On the job, the alert supervisor should find frequent opportunities to observe the extent to which the individual is able to relate himself and his job to the other functions and operations of the company.

Like human skill, conceptual skill, too, must become a natural part of the executive's make-up. Different methods may be indicated for developing different people, by virtue of their backgrounds, attitudes, and experience. But in every case that method should be chosen which will enable the executive to develop his own personal skill in visualizing the enterprise as a whole and in co-ordinating and integrating its various parts.

10. THE ADMINISTRATOR RECONSIDERED

Robert M. Hutchins*

Dr. Robert M. Hutchins comments on some problems he encountered in administering a university (University of Chicago) and a foundation (Fund for the Republic). In the process, he critically reviews a lecture he delivered on administration seven years before. Although the article is confined to "corporations not for profit," it has relevancy to administration in general.

I have spent 33 years in the administration of corporations not for profit. Seven years ago, at the University of Chicago, I gave a lecture on the administrator, and I now propose to bring that statement up-to-date and to offer some amendments to it. I should first like to reconsider my experience at the University of Chicago; then I should like to make some observations on the relatively new field of foundation administration, and finally I should like to refer to the problems that have arisen to plague the administrator since the date of the Chicago lecture.

That lecture suggested that what the administrator needed was the moral virtues and a vision of the end. I said that he had to have courage, fortitude, justice, and prudence or practical wisdom. I went on: "I do not include patience, which we are told, President Eliot came to look upon as the chief requirement of an administrator. . . . I regard patience as a delusion and a snare and think that administrators have far too much of it rather than too little."

MR. ELIOT WAS RIGHT

I have to confess that I now believe that Mr. Eliot was right, and I was wrong. I now think that my lack of patience was one of my principal disqualifications as an administrator.

I did not want to be an officeholder. I wanted, as the saying goes, "to get things done." This led me to push matters to a decision, sometimes by very close votes.

It is one thing to get things done. It is another to make them last.

I should have known that the existence of a large embittered minority, which felt that fundamental alterations had been pushed through without consideration of its point of view, destined the alterations to endure only until the minority could muster the strength to become the majority.

* From *College and University Business*, XIX, 5 (1955), 23-26. Reprinted by permission of the author and the F. W. Dodge Corporation.

As I said seven years ago, "The problem of time . . . is insoluble. The administrator should never do anything he does not have to do, because the things he will have to do are so numerous that he cannot possibly have time to do them. He should never do today what he can put off till tomorrow. He should never do anything he can get anybody to do for him. He should have the largest number of good associates he can find, for they may be able to substitute for him. But he should be under no illusions here. The better his associates are, the more things they will find for him to do."

The pressure of time is so great, the number of people who have to be convinced is so large, interminable discussion of the same subject with the same people is so boring, that the amount of patience a university administrator must have passes the bounds of my imagination, to say nothing of those of my temperament. But I have learned at last, or I think I have, that the university president who wants durable action, not just action, must have patience, and have it in this amount.

IF I HAD IT TO DO OVER AGAIN

Considerations such as these lead me to think that if I had it to do over again I might have begun at Chicago in 1929 with a proposal for the reorganization of the university more basic than any I ever advanced.

The impossible size of American universities and the lamentable extremes to which specialization has been carried lead me to believe that I should have proposed the reorganization of the University of Chicago on the lines of Oxford and Cambridge. The university should have been reconstituted into a federation of colleges, each representing among its students and teachers the major fields of learning. These colleges should have begun their work with the junior year, resting on the foundation of "the college of the university," which terminated its work at the end of the sophomore year. That college was intended to be the equivalent of the humanistic *gymnasium* or the *lycée* or the British public school. The change would have meant that basic liberal education would have been followed by compulsory communication with the representatives of disciplines other than one's own throughout the whole educational process, and, in the case of teachers, throughout their lives.

COLLEGES OF MANAGEABLE SIZE

Such colleges as these I should have proposed—say with 250 students and 25 faculty members—would be of manageable size. Each one could have an administrative officer who could be expected to lead the way to improvements both numerous and lasting. The university as a whole would

have no permanent, full-time head. The ceremonial, representative functions of the university president could be performed by a temporary official.

The only objection I can think of to this proposal is that there would be no president to raise money for the university.

The main point is that administration by persuasion and agreement, which is the only kind that brings lasting results, cannot be conducted in the vast chaos of the American university, and that the remedy for it, federalization, would also remedy that mutual deafness which specialization has made the characteristic disease of the higher learning in America.

With these important reservations and alterations, I am ready to stand on my lecture of seven years ago about the administration of universities. What about the administration of foundations, in which I have now spent almost five years? At first glance they seem like paradise for the university administrator. Foundations have no faculty, no students, no alumni, and no football team. The president of a foundation does not have to spend all his waking hours plotting how he can raise money. The Lord Chancellor of Gilbert and Sullivan said, "In my court I sit all day, giving agreeable girls away." Substitute millions for girls and you have the life of a foundation executive as it seems to a university president who has never been a foundation executive.

When one is a foundation executive one begins to appreciate certain things about universities that are not always in one's ungrateful mind when one is administering a university. The academic tradition is so attenuated in this country that the administrator of an academic institution is likely to feel that it does not exist. His preoccupation with his trustees is likely to be such that he does not notice the functioning in the university of what John K. Galbraith has called "countervailing power."

In a foundation, where there is no tradition yet and where there is no countervailing power, the administrator may recall with some nostalgia that the academic tradition did to some extent protect the academic enterprise and that the tension among administration, faculty, trustees, students, alumni, donors and the public did have a tendency to keep any group from totally destroying the independence of the academic body.

OUR COLLEGES "FOLK INSTITUTIONS"

It is true that the academic body has been in serious danger of losing its independence. The reason is that nobody can understand why it should have it. And the reason why nobody can understand this is that the colleges and universities of this country have, in their desire for popularity and money, gladly responded to every pressure and every demand. They

have insisted on their dependence; they have become folk institutions, reflecting the whims, no matter how frivolous or temporary, of those whose support they hope to gain.

In my Chicago lecture I said, "The temptation, of course, is to bury yourself in routine. There is so much routine—so many reports, so many meetings, so many signatures, so many people to see—all of some value to the institution, that you can conscientiously take your salary and never administer at all. You can spend your entire time doing things which any $30 a week clerk could do better and go home at night exhausted to report to your wife that you have had a hard day wrestling with university problems. The administrator who is determined to administer will find the strain on his character very great."

TEMPTATION TO FRITTER

In foundation work the refuge of the administrator is frittering, rather than routine, though there is plenty of that, too. The administrator of a foundation has to have a vision of the end, and, in the light of it, has to decide what expenditure is most likely to achieve it. He must decide that for the purposes of his foundation A is better than B, that X University is better than Y University, and he must do this even though B is more influential than A and Y more celebrated than X. The temptation here, of course, is to fritter, to recommend that both A and B, both X and Y, receive some money and thus to get the best of both worlds by combining popularity and effectiveness.

Most foundations, unlike the Fund for the Republic, have very general purposes, such as the welfare of mankind. The decision as to what expenditures will promote the real welfare of mankind is so difficult, it involves such a tremendous intellectual effort, which at best can result only in a guess, that a natural desire is to give nearly everybody something for nearly everything in the hope that some interesting entries will emerge for the annual report.

But this formula will not protect you today if you give something, no matter how little, to somebody who is unpopular, or if you give it for an unpopular cause. And so I come to the third and last main division of these remarks. What has happened to the administration of corporations not-for-profit in the last few years?

In the Chicago lecture I said, "The administrator who is afraid of anybody or anything is lost. The administrator who cannot stand criticism, including slander and libel, is lost." This is still true. I went on: "The natural course, then, is to become an officeholder." But even being an officeholder will not protect you now. The great change that has taken

place in recent years is a change in the atmosphere in which the administrator has had to operate. It is an atmosphere of suspicion and fear.

Since the clouds of suspicion and fear have been rolling in along with rising costs, those corporations not-for-profit which have to raise money, as all colleges and universities think they must, have felt constrained to propitiate those forces which have generated fear and suspicion or those persons and groups who have been influenced by it. Those corporations not-for-profit which do not have to raise money, like the foundations, have felt constrained to merge innocuously into the environment by veering off from any activity or from any association that could be criticized.

Now the object of universities, hospitals and foundations is not the preservation of the status quo. It is the improvement of the conditions of human life and the clarification of its aims. A university that does not try to improve the educational system and the environment in which it operates, a hospital that does not try to improve medical practice, a foundation that is not dedicated to the welfare of man is a failure. Yet universities, hospitals and foundations that do these things must inevitably engage in criticism of existing practices, and if they do they must expect to be criticized in turn.

THE NEXT WIND

And what about the next wind? The administrator ought to have a vision of the end that is clear and true regardless of meteorological conditions.

It is not merely inevitable that we are different and have different views; it is desirable that this should be so. From the clash of opinion truth emerges, and the human race advances.

Hence the essence of Americanism is discussion. It is not name calling or suppression. It is certainly not dogma or prejudice. The only political dogma in America is that discussion is the road to progress, that every man is entitled to his own opinions, and that we have to learn to live with those whose opinions differ from our own. After all, they may turn out to be right.

The administrator must have a clear, true vision of the end, and he must have courage, fortitude, justice, prudence and patience in order to pursue it through all kinds of weather. The administrator who instead of pursuing the end pursues public relations may make himself and his institution rich and popular. Public relations means trying to find out what the prevailing opinion is before you act and then acting in accordance with it.

The tendency of the pursuit of public relations is to make everybody think, look, talk and act like everybody else: How can anybody criticize

you if you are like everybody else? The pursuit of popularity brings the kind of success that turns to dust and ashes in the administrator's mouth; it means that he and his institution have failed in reality, because the end has got lost, and so they have not done for their fellowmen what they were intended to do. The moral virtues and the vision of the end—these are still what the administrator needs; he needs them now as never before.

III

DECISION-MAKING AND THE ADMINISTRATOR

11. THE AGE OF THE MANAGERS

Herrymon Maurer*

Mr. Maurer examines the development of modern management, assesses its present state, and speculates on its future. The phenomenon of the large corporation and its ramifications makes the author's article particularly interesting and thought-provoking.

For twenty-five years the managers of U.S. business have made it increasingly evident that this is indeed their age, not the age of enthroned wealth, entrenched tycoons, or enterprising manipulators of securities. Yet the role of managers—unlike that of the owners, magnates, and financiers of the past—remains incompletely assayed and popularly misunderstood. The older roles were settled and conspicuous. But modern management, self-conscious and even introspective, is engaged in constant study, experimentation, and change. The modern managerial breed is preoccupied, above all, with the future—not just the personal future, but the future of the corporation itself.

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The rapid and accelerating changes of the past quarter-century have produced a new sort of business leader, unwilling to be propelled aimlessly by the shifting winds and waves of immeasurable economic forces. A manager, indeed, might be defined as a man who wants to navigate his course of business as exactly and predictably as he can. While he makes various decisions by hunch, dead reckoning, or sudden reaction to current market conditions, he prefers to rationalize decisions, calculating the risks and analyzing the markets. He maneuvers not so much by feel as by instruments, which become more numerous—and more complex—year after year. The device of "linear programing" materialized only a few years ago, and the concept of "planning and control for profits" achieved wide acceptance only within the last five years. The various new tools, moreover, depend on other tools also relatively new: e.g., aptitude tests for future managers, precise cost-accounting systems, general economic forecasts, specific market projections.

All such tools and all the rational calculations of managers share one significant characteristic: they apply more to the economic hereafter than to the here-and-now of business life. Indeed, modern managers are distinguished by their concern with what profits, products, and markets will be in a tomorrow that may be several years to several decades distant. This preoccupation with futurity may prove to have good consequences—or bad. Will all the instruments and calculations of the modern manager rationalize away the responsibility, the intuitiveness, the personality, and even the dignity of the human beings who man large corporations? Or will they help the corporations to become still more capably managed, while remaining hospitable to the talents of individual men and women? The questions call for a new appraisal of the modern managers: where are they now, and where are they headed?

The pacesetters of management are now, by definition, the top decision makers of the largest corporations. The influence of these executives is extensive largely because of the relationship between their corporations and the many smaller companies that big business tends to breed in increasing numbers. G.M., which employs over 475,000 people, is the direct source of employment for nearly 400,000 others in dealerships and distributorships, and indirectly for perhaps a million people in 21,000 supply companies. Sears has nearly 10,000 suppliers, which employ about 1,600,000 people. Swift's retail dealers number between 300,000 and 400,000. Westinghouse has between 100,000 and 125,000 distributors and draws on the labors of an incalculable number of supplier and subcontractor employees.

Since about one out of four business employees works for the 200 largest corporations, and since these corporations make employment for at least two additional persons besides every one they employ themselves,

it is not too much to say that the management practices of the 200 largest corporations strongly influence three-quarters of U.S. business life.

1930 AND 1955

One clue to the vast economic and social consequences of management activity lies in the particular quality of competition that has become prevalent during the past twenty-five years. Large corporations are now increasing their size, activities, and earnings by creating new markets, increasing old ones, and developing new types of products. As regards new products alone, du Pont President Crawford H. Greenewalt has estimated that "half our present national working force is engaged in production and sales of things unheard of generally in 1902. A very large number are concerned with developments new since 1928. Should this trend continue, half our working population in the year 1978 may be making and selling things as yet unknown."

This type of new-product and new-market competition is not of itself a new thing; it was always a concomitant of our expanding market. But more and more managers have sharpened it into a conscious policy, by which they set out to stimulate future consumption by planning the lowest possible prices on the biggest possible output. Since managers seek in the long run to capture the highest possible sales and profits, it is significant that they emphasize decreasing price as a dynamic that makes for expanding production and, as a consequence, for lower unit costs and higher return on investment. Companies often respond to this dynamic by electing to take a temporary loss on certain products to increase their sales and consequently their production. Westinghouse, for instance, gave up the profit margin on its distribution transformers to build future acceptance for them. G.E. follows comparable practice, calls it "broadening the base."

Similarly, the dynamic concept of wages, which seemed so revolutionary when Henry Ford enunciated it in 1914, has been almost universally accepted by the managers. Partly in response to the pressures of organized labor, they treat high pay not only as an incentive to employee productivity but as a means for turning the workingman into a consumer, able in most cases to buy what he makes. An expanding market coupled with decreasing prices and increasing production is the basis for the widespread belief among managers in an expanding economy as a natural condition.

Consider now the social changes that have paralleled the growth of these concepts of management. Since 1930 not only have the poor become richer but the rich poorer. Child labor has disappeared. The gulf between classes has narrowed abruptly. Big houses are smaller, small

houses bigger. Servants are disappearing from the homes of the well-to-do, and the street and sports clothes of the assembly-line worker are hard to distinguish from those of executives. Employees now take for granted goods, products, services, standards of living, levels of education, and even types of architecture that not long ago would have seemed beyond the reach of anyone but bosses. Meanwhile, paid vacations, medical benefits, insurance, and pensions have become prevalent among large corporations. Unionism, long fought violently, has within twenty-five years become a necessary part of large industrial establishments.

THE NEW TRANSACTION

More social change and marked alterations in management will probably follow the new preoccupation of business with the future. The lag in time between decisions and sales is increased, of course, by the technological complexity of new products and new plants. Nowadays, many managers find themselves committing funds for research, development, engineering design, and capital expansion that cannot produce income for five to ten or more years. They have to deliberate levels of price and pay, themselves complex considerations easily influenced by many still unknown factors, and they have to weigh as rationally as possible the effect of these levels upon distant levels of production and the even more distant shape of the market. Meanwhile, they have to respond as sensitively as possible to studies of what business conditions may conceivably be many months or many years hence.

Thus managers look ahead in a more sophisticated way than they formerly did. They make decisions that are considerably separated in time from the market transactions to which the decisions are supposed to lead. Du Pont spent twelve years' time and $27 million in research and development to get nylon into production. Before R.C.A. sold its first television set, it also put $50 million into research and development. Some years ago the Santa Fe purchased several hundred acres of land adjoining its properties in Los Angeles after a five-year study of what the land needs of the railroad might be fifty years thence. It takes Consolidated Edison two years to plan a modern, complex generating station and from three to five years more to complete it. For some time Sears has been expanding its store selling area in the South (its square footage per capita of population is already greater there than in any other part of the country) out of a conviction that natural resources, population growth, and the stimulus of Sears' eleemosynary programs will make the South more prosperous fifty or so years hence. As early as 1929, Alcoa built a mill at Massena, New York, to roll large structural shapes for which there was not any market, and has recently built another at Davenport, Iowa, to roll unusually wide

sheets although the market cannot begin to absorb the output for some years to come.

At Union Carbide & Carbon, the time lag between test tube and tank car is ten years for "simple" projects; but there was a gap of twelve years for Vinylite, more than seventeen for coal hydrogenation. At Sears, schedules are worked out with suppliers for products that may not be selling until after four, seven, or more years. Washing machine production—complete with program for cutting costs, improving quality, and reducing seasonal fluctuations—is written down in a manual that covers the next four years. In sum, big-company managers are engaged in a continuum of business decisions separated by a chasm of days, months, and years from a continuum of market transactions.

NEW FORESIGHT

Solicitude for what will be, and how it will affect the long-term production, prices, and profits of a corporation entails, first of all, a willingness to refrain from squeezing the last drop of profit out of current operation. Managers often fall heir to profits resulting from decisions made prior to their own appointment to decision-making jobs. This circumstance usually convinces them that sacrifice of maximum profits and dividends today is often essential to provide a higher level of profits in another top-executive generation. In fact, almost any manager can point to particular uses to which today's profits can be put for tomorrow's profits: research, for example. Obviously, a decision to expand plant is an employment of money in hand to create money in some future bush. Sometimes profits are plowed back and dividends held down. Sometimes money is borrowed and current costs increased. And always there is the overhead of research, engineering, development, and design. Such decisions, of course, are encouraged by the federal tax structure with its provisions for capital gain and rapid depreciation.

In 1953 the plow-back rate of earnings was 50 per cent, compared with 30 per cent in the Twenties. Even among utilities that go into the security market for their expansion needs, there is a readiness to shoulder the risks of investing great sums of money at times when costs are high. The Bell System, for instance, conceivably could have safeguarded its profits by dragging its feet when postwar demand for telephones mounted, but it took on a construction program that now exceeds $9 billion—more than the company's total assets at the end of the war.

The managers of large corporations, moreover, usually have concrete plans to ensure the flow of raw materials critical to the company's future earnings. Witness the exploration programs of the big oil companies. Witness also U.S. Steel's iron hunt. The corporation presumably could have found a more attractive return on its money than its high-cost tidewater

Fairless Works, erected to process Venezuelan ore. But had the company not elected to build this plant, it would have lacked the means to compete with other manufacturers on the eastern seaboard. Comparable in urgency is American Can's intensive effort to find materials to take the place of tin, of which there is a free-world supply of twenty-three years if deposits adjacent to Communist areas are not lost, or enough tin for just five years if the deposits are lost. "So far as I am concerned," remarks President William C. Stolk, reviewing his company's efforts to anticipate the future, "this is the day after tomorrow."

Managers today do not merely look to the future, or guess at the future, or simply let the future come to pass. They consciously analyze, calculate, project, and predict. So rationalized are their decisions that they lead to conscious and continuous planning of the whole of a corporation's activities. This planning is flexible, to be sure; most programs provide for cutbacks at the drop of an index. But few programs can be cut out altogether. There are basic decisions, including commitments of money, that could be altered only by major economic reversals. When such basic decisions are being made from one to a dozen years ahead in a segment of U.S. enterprise potent not only in its immediate effect on the economy but also in its effect on an army of suppliers, subcontractors, dealers, and distributors, the economy no longer simply happens; it is to a very considerable extent planned. And the planning is done by the forward programs of managers themselves. The actual planning period is stretching constantly: many managers, indeed, project even the ordinary events of their businesses and draw up detailed profit-and-loss statements for a rolling five-year period.

NEW MARKETS

Novel as this conscious sort of planning is, it involves other novelties, one of which is anticipating and creating future markets. A calculated market, clearly, is something different from the market places of earlier times, or from the commodity and security exchanges of today. Most corporations today are concerned not with actual places of exchange but with market potentials for particular products in particular areas. Thus there is the Midwest rural market for cake mixes or the suburban market for air conditioners. In competing for shares in such markets, managers must draw on studies of economic trends, projections of population statistics, estimates of future income within the market, and other indications of distant sales potentials. The remarkable fact about this uncertain sort of market is that most managers are confident in their anticipation of it.

One reason for confidence is a belief by many managers that the planning process itself may contribute to the stability and growth of the economy and may help limit the swings of the business cycle. If G.M. has

spent money during the past ten years that it must recover during the next ten; if du Pont is putting into production products that came out of a test tube eleven years ago; if U.S. Steel has committed itself not only to the costs of finding ore but also to the costs of transporting and processing it; if the Bell System has spent over $9 billion on expansion largely to anticipate future demand; if, in short, several hundred large companies, together with the small companies grouped around them, have gone to great expense in planning future products and plants and have taken great pains to calculate the chances of this expense producing future profits, then a significant stabilizing force has been brought to bear on the economy.

Since flexibility is a purposely built-in feature of most plans, managers can tailor part of their programs to the emerging shape of the economy. There remain, however, incalculable economic forces. It may be, for instance, that the heavy use of profits for capital expansion in recent years reflects stockholder interest in capital gains rather than in dividends; and it is conceivable that more expansion has occurred than the markets for goods justify. On the other hand, the caution with which managers tend to calculate future markets probably reduces the likelihood of such a dangerous imbalance.

Ask a manager how he actually makes plans and he will describe how his company is organized. While rational organization of the labor of many employees is a long-established fact of large enterprises, the organization of executives is recent. In most companies, indeed, the shift from one-man rule, or undefined rule, has occurred within the last twenty-five years. Authority and responsibility have been decentralized to the end that executives down the line may know what role they play in current activities and in future planning. At the same time, top managers are putting new emphasis on the function of central control, trying to find the correct balance between decentralization and integration of management.

THE NEW EXECUTIVE

Modern organization systems are seldom final. Just as managers are forever planning the future, so are they forever reorganizing themselves. But there is one crucial principle that does not change: on every executive level, many of the decisions are the result of the interaction of many men, even if the decisions are formalized by individual managers. Group management has become characteristic of the large corporation. The corporation's activities, particularly its future plans, are simply too vast for one man to keep in his head. Union Carbide, for instance, acts on the premise that major decisions for the future demand collective judgment. President

Dial presides at committee meetings, but decisions result from an interaction of minds, with consequent compromises, and major commitments are always unanimous. "When you have more new things than you have money," he points out, "you don't do anything unless the reasons are overpowering and you all agree."

It follows that the job of such a manager as Morse Dial is to use the ideas of his fellow managers. In that role there is only limited scope for a man to practice some previous specialty. In decades to come, the U.S. is likely to see more and more managers who are not so much experts in law or finance or production or research, as in the art of management itself, and who still know how to get the highest volumes of sales and profits out of highly specialized undertakings. Of B. F. Goodrich's President William Richardson, a manager without formal training in chemistry, Sidney Weinberg has said, "I don't know any man who knows more about the chemical business." And du Pont's Greenewalt has noted that "specific skill in any given field becomes less and less important as the executive advances through successive levels of responsibility. . . ."

THE NEW ATTACHMENT

Compared with businessmen twenty-five years ago, today's managers exercise less individual power, definitely take home less money, probably enjoy less popular recognition. Generally speaking more money is to be had by entertainers, more power by men in government, more recognition by athletes. Under such circumstances, what motives make managers work—work harder, longer, and with greater dedication than the men of twenty-five years ago? The motives are unquestionably mixed, ranging from money and success to satisfaction in making mammoth organizations tick. But many top managers profess an additional motive growing out of the group deliberation that so often decides future business plans. For good or ill, the corporation is frequently the executive's club, and to some extent (or so his family complains) his home. Leroy Wilson, late president of A. T. & T., liked to stress the satisfactions of working with like-minded people. Union Carbide executives actually refer to their company as "the community." James T. Leftwich, president of F. W. Woolworth, says simply, "We live Woolworth."

This bond to the company is reinforced by a significant trend toward setting recompense for managers essentially by policy. There is a declining turnover of top executives in most industries (notable exceptions: aircraft, textile, amusements), and recompense can seldom be set in terms of competitive bidding for talent. It is set most often in terms of "what the job is worth." This development reflects the increasing confinement of

executives to the preserves of their own companies. And the confined executive may well be the sort of man who centers his entire life around his company, from which alone he is certain of employment, and to which alone he is able to look for old-age income. The policy-set salary thus becomes a symbol of a community closed to outsiders.

In many ways the development of a community of executives can be salutary. The corporation ceases to be a mental abstraction or—what it is legally supposed to be—a fictional person, devoid of spirit and life. It becomes a group that gives a man the sense of being an integral and valuable part of a common effort. The group, moreover, meets his money needs, offers legal advice, medical service, loans when needed, advanced education, even travel. It takes note of the birth of children, regularly attends funerals.

Group management, however, has pitfalls. Big companies already have unique traits and habits, so that it is possible to speak of a G.E. man or a G.M. man or a Bell System man (once labeled *homo telephonicus*). Cohesiveness is one of the certainties of life at B. F. Goodrich, top moneymaker among rubber companies per dollar of sales. "We all work so closely," says one Goodrich man, "that we know what each other is thinking." If such closeness of purpose should lead to dull uniformity of mind, there would be danger: obvious danger to the profits and productivity of American industry because of closed-mind business thinking wherein each executive would repeat a line of ideas common to the group, and wherein no executive would offer fresh slants or new flashes of insight. A more insidious danger would be the violation of the democratic belief that the individual human being is unique, unrepeatable, and no man's copy.

These dangers, to be sure, do not show up conspicuously among contemporary managers, most of whom have experienced the rough-and-tumble of individualistic enterprises in times past. Young executives, however, obviously lack this experience. There are signs, moreover, that some companies select and advance young executives partly on their ability (and even that of their wives) to conform to a company's pattern. There are also signs that an increasing proportion of younger managers, unlike their elders, are sons of men who were themselves executives. Thus there arises the unhealthy possibility of a self-perpetuating managerial elite.

NEW OPPORTUNITIES

Group enterprise, indeed, offers alternatives both hopeful and horrible. It is conceivable that such enterprise will be the prototype of social slavery, that it will be the agent of a soul-rotting decay that shreds the last remnants of man's dignity. But it is also conceivable that the large corporation will emerge as a new social force whose basic drive is the

creativity of individual human beings. The American people will, of course, make the choice between these alternatives, but the actual shaping of the alternatives will in large part be the work of tomorrow's managers.

Some of the managerial decisions will have to do with the forms of group enterprise itself. Others will center on more diverse social responsibilities. Already the new management provides or extends employee benefits, supports charitable and educational activities, works at cut-rate profits for the government—a dollar a year in the case of du Pont's and G.E.'s atomic projects. There have been experiments with guaranteed annual pay, with wage increases based on productivity. There are an increasing number of programs to bring employees as well as executives into the corporate community. Such a program at Jersey Standard has helped maintain peaceable labor relations for more than thirty years.

NEW RELATIONSHIPS

The question for the future is how well the new management, and the American people, understand the relationship between these social responsibilities and the economic functions of the modern corporation. And here the beginning of wisdom lies in two propositions:

All the "strictly economic" functions of management have weighty social consequences.

The ability of modern management to carry out its "social" responsibilities rests on economic performance—i.e., profitability.

It is futile for a big corporation to talk of being "a good citizen" if it is not meeting the first test of corporate citizenship: production and distribution at such prices and in such volume as to elevate the U.S. standard of living—on profit margins that assure its ability to attract capital, raise productivity, and yet again enhance the standard of living. It is equally unrealistic for a big corporation to pretend that the market is the only payoff on its activities; a corporate decision to have *no* social policies is actually an economic decision with adverse effects on profits.

Much of U.S. management would subscribe to the foregoing, but few managers are entirely free of embarrassment in explaining to employees or the public the "social" value of profits or in explaining to fellow managers the "economic" value of decency. This slowness in recognizing the essential unity of a company's multitudinous affairs suggests that managers themselves are not yet fully aware of the logic of the large corporation with its emphasis on doing now whatever will contribute most to the health (i.e., profits) of the corporate community in the future.

This difficulty is important because a substantial part of the American people adhere to stereotypes about managerial enterprise even though the stereotypes are only rough caricatures of business activity twenty-five or

more years ago. Many people still suppose that managers are the rapacious spokesmen of "vested interests" threatening the economic stability of the country.

NEW EXPLANATIONS

Obviously, the persistence of such misunderstanding means that large corporations, only recently rehabilitated in public esteem, are still potentially subject to attack in the future, conceivably to increased government control. Today's managers cannot be held wholly responsible for the misunderstanding. Managerial enterprise is too new to be understood quickly and fully, let alone explained. The responsibility therefore falls upon tomorrow's managers. Certainly it should not take many more years' experience in the logic of the large corporation to find ways to explain the dynamism and stability that managerial planning brings to the economy, or to make clear that the strenuous competition vital to productive efficiency is not of a dog-eat-dog character.

Nor should it be difficult to demonstrate that large corporations are subject not only to law but also to effective economic controls: first, competition itself, which ensures high production at low prices and also measures efficiency and foresight; second, the economic vote of customers, to which managers must respond sensitively if they want to stay in business; third, the major test of competence, profits on investment; fourth, public opinion.

Nor should tomorrow's managers find it hard to demonstrate the concern of big companies for social values. The large corporation today is not out of harmony with a papal encyclical (considered radical when issued in 1891) which declared that a market wage was not necessarily a just wage, voiced approval of unions, and emphasized that people other than property owners had needs. Nor is the corporation out of harmony with comparable but unofficial statements published in the late forties by the Federal Council of Churches. Managers would agree that man is not a mere economic creature, that labor is not a mere commodity, that the fullest possible employment is a social good, that prices should stimulate consumption, and that workers should get more than subsistence pay.

NEW MEN

How well tomorrow's managers will do their social and economic jobs depends on the sort of men—alert, creative individuals or conforming robots—that managers now in office are choosing to succeed them. And

making the right choice is clearly complicated by the existence of group-minded executive communities, many of which—fortunately not all—are in effect closed to outsiders.

Here is an immediate opportunity that can have far reaching benefits. Today's managers can reverse the long trend toward advancement strictly from the inside, outlaw the executive closed shop, and re-establish an executive market in which their various companies can actually bid for talent. Today, when the art of management is more important than special skills, executives ought to be free to circulate more easily than in the past. And such circulation as does occur indicates that neither the group deliberation not the *esprit* typical of the new management would suffer from occasional infusions of fresh talent. Indeed, the first job of the present generation of managers may well be to keep the future managers out of institutional ruts.

12. MANAGERIAL DECISION-MAKING

Robert Tannenbaum*

Professor Tannenbaum explores the fundamental nature of decision-making and the factors influencing its practice, behavior, and acceptance. An article by Professor Tannenbaum (on p. 16) may be regarded as a first part or introduction to the present one.

THE NATURE OF DECISION-MAKING

INTRODUCTION

Human behavior results from either unconscious or conscious processes. When these processes are conscious, decision-making is involved. Decisions, when made, affect the behavior of an individual. An individual may make decisions which affect his own behavior, or he may make them to affect the behavior of another or others. In the latter case social processes are involved.

Managers are those who use formal authority to organize, direct, or control responsible subordinates in order that all service contributions be co-ordinated in the attainment of an enterprise purpose. One of the most

* From *The Journal of Business*, XXIII, 1 (1950), 22-39. Reprinted by permission of the University of Chicago Press.

important techniques of managers is that of decision-making. This technique pervades the performance of all the functions of managers.[1] In order to organize, direct, or control responsible subordinates, managers must make decisions which affect the behavior of those subordinates. The decisions of managers are made not to affect their own behavior but rather that of others. On the other hand, nonmanagers, in performing their work, must also make decisions, but these decisions affect only their own

[1] Robert Aaron Gordon has developed the following incomplete, but informative, classification of the more important types of business decisions:

"I. Promotion and initial organization
  "A. Determination of main objectives
  "B. Setting up initial organization, involving:
    "1. Decisions as to size, legal organization, financial structure, internal organization, specific products to be produced and methods of producing and distributing them, and so on
    "2. Choice of key personnel
  "C. Negotiation for the hire of the factors of production, particularly capital
"II. Existence as a going concern
  "A. Maintenance of organization through personal leadership and continuous exercise of authority
  "B. Determination of the more important decisions relating to:
    "1. Volume of output and control of production
    "2. Prices
    "3. Marketing (sales organization and methods, advertising, purchasing, and so on)
    "4. Wages and other labor problems
    "5. Financial problems, such as changes in capital structure, maintenance of working capital, securing new funds, and so on
    "6. Changes in the size of the firm (expansion or contraction)
    "7. Changes in the location of the firm or of important branches
    "8. Changes in internal organization and procedures
    "9. Changes in products and in (technical) methods of production
    "10. Relations of the firm with outside groups, either with specific groups, such as consumers, bankers, or government, or with the public in general (that is 'public relations')
    "11. Distribution of profits
  "C. Choice of the men who will make the above decisions and also of those primarily responsible for directing the execution of them
"III. Reorganization or liquidation
  "A. Reorganization
    "1. Decision to reorganize
    "2. Determination, for the transition from the old to the reorganized firm, of the matters listed under I
  "B. Liquidation
    "1. Decision to liquidate
    "2. Deciding the terms for the liquidation, primarily with respect to the distribution of assets"

(*Business Leadership in the Large Corporation* [Washington: Brookings Institution, 1945], pp. 53-55.)

And Edwin O. Stene has said: "Decision is necessary whenever an organization is formed, whenever routine interactivity is deliberately changed, and whenever action is called for which has not become routine in character" ("An Approach to a Science of Administration," *American Political Science Review*, XXXIV [December, 1940], 1130).

behavior. The decisions of managers have a social import; those of non-managers, an individual import. Furthermore, decisions are made by other individuals and groups which affect the behavior of managers. These decisions also have a social import.

In the discussion which follows, primary attention is given to decision-making in its social context, since this is the context which is relevant in so far as an understanding of the work of managers is concerned. First, the nature of decision-making will be analyzed. Then the interindividual and intergroup relationships which make it possible for the decisions of one to affect the behavior of another will be explored. And, finally, the conclusions will be related to the work of managers, indicating how managers affect the behavior of their subordinates and how others affect the behavior of managers.

THE DECISION-MAKING PROCESS

Etymologically, "to decide" means "to cut off." In its present usage it suggests the coming to a conclusion. It "presupposes previous consideration of a matter causing doubt, wavering debate, or controversy and implies the arriving at a more or less logical conclusion that brings doubt, debate, etc., to an end."[2]

Decision-making involves a conscious choice or selection of one behavior alternative from among a group of two or more behavior alternatives.[3] In making a decision, an individual must become aware of relevant behavior alternatives, define them, and finally evaluate them as a basis for choice. To understand clearly what is involved in the making of a decision, it will be helpful carefully to examine each of these steps in the decision-making process.

1. Awareness of behavior alternatives.—Before making a decision, an individual should become aware of *all* those behavior alternatives which

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[2] "Decide," *Webster's Dictionary of Synonyms.*

[3] Various attempts have been made to define "decision." Examples of these are: "The selective determination of an end for action by choice between alternatives" ("Decision," *Dictionary of Philosophy and Psychology*, ed. James M. Baldwin, Vol. I [1940]); "Decision is the conscious consideration and conclusion regarding a course of action" (Stene, *op. cit.*, p. 1130); "A preliminary to conscious activity is a decision between alternatives—to do this or to do that, to do or not to do. In the process of decision-making the individual assesses a situation in the light of these alternatives. A choice between values congenial to the larger value-system of the individual is somehow reached" (R. M. MacIver, *Social Causation* [Boston: Ginn & Co., 1942], p. 296); "At any moment there are a multitude of alternative (physically) possible actions, any one of which a given individual may undertake; by some process these numerous alternatives are narrowed down to that one which is in fact acted out. The words 'choice' and 'decision' will be used interchangeably . . . to refer to this process. Since these terms as ordinarily used carry connotations of self-conscious, deliberate, rational selection, it should be emphasized that as used here they include any process of selection, regardless of whether the above elements are present to any degree" Herbert A. Simon, *Administrative Behavior* (New York: The Macmillan Co., 1947).

are relevant to the decision to be made. But this is seldom, if ever, possible. To a considerable extent he must depend upon his own limited experience and information. And memory of these is often sketchy and incomplete. He can discover relevant behavior alternatives through investigation, by tapping the experience and knowledge of others. But this process is often excessively time-consuming and does not guarantee complete coverage of all alternatives. For these reasons, it is exceedingly doubtful whether most decisions are based upon an awareness of all relevant behavior alternatives.

2. Definition of behavior alternatives.—Once the individual has become aware of certain behavior alternatives, he is next faced with the problem of defining each of them. Ideally, this definition involves a determination of *all* the consequences related to each behavior alternative under consideration; but this ideal can never be achieved for the following reasons: (*a*) The most significant characteristic of the behavior alternatives is that their consequences lie in the future and therefore must be anticipated. But whenever the future is anticipated, uncertainty is present. This uncertainty is present for two reasons. In the first place, an individual never has the knowledge to make it possible for him accurately to determine the nature of the consequences which will follow upon the choice of a given behavior alternative or their probability of occurring, assuming that all other related elements remain constant. And because he does not have knowledge of the future, he must use imagination in attaching values to the consequences, which values may not obtain when the consequences are actually experienced. In the second place, all other related elements will not remain constant. (*b*) It is impossible for an individual to be aware of all the consequences attendant upon any given behavior alternative. (*c*) The time involved in discovering consequences and determining their nature is often such that a decision must be made before all the foreseeable relevant possibilities can be explored.

3. Evaluation of behavior alternatives.—After an individual has become aware of certain behavior alternatives and has considered many of the consequences attendant upon each of these alternatives, he must next exercise a choice between them, i.e., make a decision. What can be said of the mental processes which culminate in decision?

The decisions which an individual makes are basically of two types. Some (a very small proportion) of his decisions relate to his system of values—they determine his ultimate ends. All other decisions are directly or indirectly related to means for the attainment of these ultimate ends. The adjective "ultimate" is used advisedly. An individual's behavior is guided by innumerable intermediate ends, for each one of which there are related means. And the end of one means-end nexus becomes a means to a higher-order end. Decisions relating to ultimate ends cannot be judged

as to their efficacy. They have primarily an ethical content. But such is not the case with all other decisions. These are made in terms of related intermediate ends. In choosing between alternatives, a rational individual will attempt to make a selection, within the limits of his knowledge, which will maximize results (the degree of attainment of the relevant end) at a given cost or which will attain given results at the lowest cost. Thus, he has a criterion to guide his choice—the criterion of rationality.

There are definite limits, however, to rational behavior viewed objectively (i.e., from an omniscient point of view). These limits stem from the individual's lack of knowledge with respect to the existence of behavior alternatives and the consequences that will follow from them both from the subjective processes which are necessarily involved in defining alternatives when uncertainty is present, from time limitations, and from the psychological difficulties involved in holding alternatives and their consequences in focus preparatory to making a decision. Because of these factors, it is next to impossible to describe the mental processes which culminate in decision.[4]

The necessity for making decisions arises out of the fact that knowledge of relevant existing facts is inadequate and that the future is uncertain—individuals can never have complete knowledge of all factors underlying their choices. If such knowledge were available, decisions would not have to be made. If an individual were aware of *all* the consequences related to each of these behavior alternatives, judgment would not have to be exercised. One alternative would clearly be superior to all others. Individual behavior could be completely rational. In a real sense, that behavior would be determined by the consequences related to the superior alternative rather than by a choice between alternatives. The relationship of uncertainty to decision-making has been stated by Frank H. Knight as follows:

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[4] On this matter, Frank H. Knight has made the following observations: "The mental operations by which ordinary practical decisions are made are very obscure, and it is a matter for surprise that neither logicians nor psychologists have shown much interest in them. Perhaps (the writer is inclined to this view) it is because there is really very little to say about the subject . . . when we try to decide what to expect in a certain situation, and how to behave ourselves accordingly, we are likely to do a lot of irrelevant mental rambling, and the first thing we know we find that we have made up our minds, that our course of action is settled. There seems to be very little meaning in what has gone on in our minds, and certainly little kinship with the formal processes of logic which the scientist uses in an investigation. We contrast the two processes by recognizing that the former is not reasoned knowledge, but 'judgment,' 'common sense,' or 'intuition.'" (*Risk, Uncertainty, and Profit* ["Series of Reprints of Scarce Tracts in Economic and Political Science," No. 16 (London: London School of Economics and Political Science, 1933)], pp. 267 f.). Likewise, MacIver states: "There are unfathomed psycho-organic processes involved in the formulation of the dynamic alternatives, in the choice between them, and in the passage of decision into action" (*op. cit.*, p. 333).

> . . . With uncertainty absent, man's energies are devoted altogether to doing things; it is doubtful whether intelligence itself would exist in such a situation; in a world so built that perfect knowledge was theoretically possible, it seems likely that all organic readjustments would become mechanical, all organisms automata. With uncertainty present, doing things, the actual execution of activity, becomes in a real sense a secondary part of life; the primary problem or function is deciding what to do and how to do it. . . .[5]

One further point demands attention in connection with this discussion of the nature of decision-making. What initiates the decision-making process? At any given moment of time, there are often many problems which might compete for an individual's attention. What determines the particular problem with which he will deal? Simon points out that decision-making is initiated by stimuli, internal or external to the individual, which channel his attention in definite directions. Very often these stimuli, impinging upon the individual, are accidental and arbitrary in character. To the extent that they are, the individual's behavior cannot be rational. Also, since the attention-directing stimuli can be external to the individual, they can be provided by others who desire to affect the individual's behavior.

The preceding discussion of the nature of decision-making has, for the most part, dealt with decision-making in the abstract. It has indicated the limits to rational behavior on the part of the relatively isolated individual —limits which are greatly reduced when the individual is a member of a group, as will be pointed out later. Decision-making actually takes place in an environment which significantly affects the decision-making process. In the two sections which follow, the various aspects of this environment will be explored in considerable detail.

THE CONCEPTS OF AUTHORITY AND INFLUENCE

INTRODUCTION

At the beginning of the preceding section it was stated that an individual may make decisions which affect his own behavior, or he may make them to affect the behavior of another or others. The latter case, as was pointed out, is the relevant one in so far as the work of managers is concerned. This relevancy is present for two reasons. First, in order to organize, direct, and control responsible subordinates, managers must make decisions which affect the behavior of those subordinates. And, second, managers themselves are in a subordinate position both with respect to their own superiors and formal subordinates within an enterprise and often with respect to others. Thus managers make decisions affecting the behavior of subordinates at the same time that decisions are being made which affect their own behavior. The concern here, then, is with social processes.

[5] *Op. cit.*, p. 268.

These processes are those of authority and influence. In this section the discussion will be devoted to an analysis of these two processes.

THE NATURE OF AUTHORITY

A superior is able directly to affect the behavior of a subordinate if he possesses authority with respect to that subordinate. In the preceding article it was stated that authority is commonly viewed as originating at the top of an organizational hierarchy and flowing downward therein through the process of delegation. When viewed in this way, it was called "formal authority." In reality, effective authority does not originate in this manner.

The real source of the authority possessed by an individual lies in the acceptance of its exercise by those who are subject to it. It is the subordinates of an individual who determine the authority which he may wield. Formal authority is, in effect, nominal authority. It becomes real only when it is accepted. An individual may possess formal authority, but such possession is meaningless unless that authority can be effectively used. And it can be so used only if it is accepted by that individual's subordinates. Thus, to be effective, formal authority must coincide with authority determined by its acceptance. The latter defines the useful limits of the former.

The concept "authority," then, describes an interpersonal relationship in which one individual, the subordinate, accepts a decision made by another individual, the superior, permitting that decision directly to affect his behavior. An individual always has an opportunity, with respect to a decision made by another directly to affect his behavior, to accept or reject that decision. If he accepts it, he thereby grants authority to its formulator and, for this matter, places himself in the position of a subordinate. As a subordinate, the individual permits his behavior directly to be affected by the decisions of his superior. If the individual rejects the decision, he does not grant authority to its formulator. Thus the sphere of authority possessed by a superior is defined for him by the sphere of acceptance of his subordinates.

If this line of analysis is to be followed it must be recognized that an individual may possess authority in a given situation without having formal authority. In other words, the channels through which effective authority is exercised do not have to follow the lines of formal organization within a given complex. And these channels may extend outside the given complex.

DETERMINANTS OF THE ACCEPTANCE OF AUTHORITY

Since the sphere of authority possessed by a superior is defined for him by the sphere of acceptance of his subordinates, it is important to inquire into the factors which determine this latter sphere. Why do subordinates

accept, rather than reject, the authority of their superiors? In answering this question, it must be remembered that the choice between acceptance or rejection involves a decision between two alternatives. This choice is made only after the individual has appraised, to the extent possible, the consequences attendant upon each of these alternatives.

An individual will accept an exercise of authority if the advantages accruing to him from *accepting* plus the disadvantages accruing to him from *not accepting* exceed the advantages accruing to him from *not accepting* plus the disadvantages accruing to him from *accepting;* and, conversely, he will not accept an exercise of authority if the latter factors exceed the former. Thus a decision to accept or reject a given exercise of authority results from a relative evaluation of the consequences—both positive and negative—attendant upon the choice of each of the competing behavior alternatives. To understand better the factors underlying a decision to accept or reject, it will be helpful to consider in more detail the nature of the positive and negative consequences—the advantages and disadvantages—related to each behavior alternative.

The possible advantages accruing to an individual from accepting a given exercise of authority are many. While the following listing of types of advantages is by no means complete, it will serve the end of indicating the variety of such advantages: (1) By accepting an exercise of authority, an individual is able thereby to contribute to the attainment of an enterprise purpose which he recognizes as being good.

It was pointed out that group activity involves the specialized service-contributions of individuals which must be co-ordinated in the attainment of an enterprise purpose. Such co-ordination can be achieved only through the exercise of authority on the part of the individual who heads the group. An awareness of this necessity leads individuals who recognize the enterprise purpose as being good to accept authority. (2) By accepting an exercise of authority, an individual may thereby attain the approbation of his fellow-workers. For most individuals, social acceptance is a strong motivating factor. (3) By accepting an exercise of authority, an individual may thereby obtain rewards from his superior. These rewards might be increased pay, promotion, prestige, opportunity for increased personal power, and the like. (4) By accepting an exercise of authority, an individual may thereby be acting in accordance with his own moral standards. Some individuals believe they ought (that it is right) for them to obey duly constituted authorities. (5) By accepting an exercise of authority, an individual may thereby avoid the necessity of accepting responsibility. (6) Finally, by accepting an exercise of authority, an individual may thereby be responding to the qualities of leadership exhibited by his superior. In part, this point overlaps some of the preceding ones, but it also includes a recognition of the fact that some individuals obey others

out of respect for their age, superior ability or experience, character, reputation, personality, and the like.

An individual, after considering the advantages to him, may often decide to accept an exercise of authority. Such a choice would be a free one—one not involving compulsion. But he might also decide to accept an exercise of authority even though the advantages attendant thereto, taken alone, would not be sufficient to induce him to accept. In this case his decision would be compelled by another or others; he would simply acquiesce to authority because of the disadvantages accruing to him from not accepting. When an individual is forced by another to do something against his will—something he otherwise would not have done—coercion is involved. Horace M. Kallen has defined and elaborated upon the concept of coercion in these terms:

> Coercion as a trait of human behavior may be said to obtain wherever action or thought by one individual or group is compelled or restrained by another. To coerce is to exercise some form of physical or moral compulsion. . . .
> . . . When it [coercion] is direct we call it physical; when indirect, moral. Both compel or restrain conduct by *force majeure*. . . .
> Most social coercion is indirect; it only threatens force. . . . But all coercions involve fear of penalties. Without belief that the coercer can and will impose penalties no indirect coercion can be effective. . . .[6]

There are numerous coercive devices the actual use or fear of which is often effective in obtaining an acquiescence to authority. Some examples of these are social disapprobation, expulsion from a group (ostracism), formal disciplinary action, exertion of economic pressure (monopolistic and monopsonistic power), torture, imprisonment, taking of a life, etc.

In order to understand the full implications of coercion, it will be useful briefly to digress in order to contrast this concept with the concept of sanctions. In every social group there are certain modes of behavior which are generally approved and others which are generally disapproved. The reactions of approval and of disapproval represent general formal or informal social consensus. Now in every group there are some individuals who have urges toward nonconformity. Sanctions are devices used to induce these individuals to conform to the group will. Sanctions may be positive or negative in character. Positive sanctions are the social reward of conformity, and negative sanctions are the social consequences of nonconformity. All negative sanctions are coercive in their effect—they are used to impel an individual to conform against his will to group norms of behavior. Heads of groups who impose negative sanctions on recalcitrant individuals have the support of the vast majority of the group in so doing. But heads of groups might also induce conformance to behavior patterns which are not generally approved by the group. Here coercion

[6] "Coercion," *Encyclopaedia of the Social Sciences,* Vol. III (1930).

is involved but not negative sanctions. Furthermore, one individual with respect to another individual or a group or one group with respect to another group or an individual outside the group might induce conformance to specified behavior patterns through the use of coercion. But here again negative sanctions are not involved. Thus coercion includes more than negative sanctions. The latter term is applicable only when general group consensus is involved. When the head of a group uses coercion not based upon general group consensus, he is acting in an autocratic or arbitrary manner.

In raising the question as to whether an individual will accept an exercise of authority, only the advantages accruing to him from accepting plus the disadvantages to him from not accepting have thus far been considered. But he will accept only if these factors exceed the advantages accruing to him from not accepting plus the disadvantages accruing to him from accepting, as has previously been pointed out. These latter factors, however, are the same in nature as the former ones. An illustration should suffice to make this clear. An employee may be a member of a group most of whose members are restricting output in opposition to a wage-incentive plan. The implied or explicit order of the employee's boss is that each employee should produce the maximum output reasonably possible. Should the employee accept this exercise of authority, or should he restrict his output (i.e., accept the authority of the work group)? If he accepts the authority of his boss, he can earn more, he may get a desired promotion, etc. If he does not accept, he may be demoted or fired. On the other hand, if he does not accept, he may receive the approbation of his fellow-workers, additional status in the group, etc. And if he accepts, he may receive the disapprobation of his fellow-workers or be ostracized from the group. His decision to accept or not accept the boss's exercise of authority will be based upon an evaluation of these and similar relevant consequences.

In order to make complete this discussion of the determinants of the acceptance of authority, one further point calls for attention. Authority is often accepted where conscious processes are not involved. Such acceptance does not entail a conscious choice between acceptance and rejection. Rather, it is reflective of unconscious, habitual processes.

AUTHORITY VERSUS INFLUENCE

The use of authority is one means of affecting the behavior of another. The subordinate who accepts an exercise of authority does not critically evaluate the behavior alternatives underlying the decision of his superior. He accepts the decision and permits it directly to affect his behavior. But

there is another means by which one individual can affect the behavior of another. In this case the latter individual is free to make those decisions which directly affect his own behavior. But, since he never has complete knowledge with respect to all relevant behavior alternatives and to all the consequences related thereto and since the ends toward which he directs his behavior are subject to change, it is possible for another individual or for others to provide him with information which can affect his decisions. This additional information simply adds to or changes the relevant factors (means and ends) which he otherwise would take into account in arriving at his decision. It might or might not result in a decision different from the one that would otherwise be made. In any event, the individual, taking the additional information into account, freely arrives at his own decision. Such provision of relevant information by one person to another (who then takes that information into account in arriving at a decision) will be called "influence."[7] The individual who exercises influence may offer advice, make suggestions, enter into discussions, persuade, use propaganda, and the like; but he does not exercise authority. In so doing, he indirectly affects the behavior of another.

Managers make decisions to affect, both directly (through authority) and indirectly (through influence), the behavior of their subordinates. And, likewise, others make decisions which similarly affect the behavior of managers. In the two sections to follow the next one, the implications of these decisions for the performance of the functions of managers will be considered in detail. But, first, some additional factors relevant to decision-making will be explored.

SPHERES OF DISCRETION

CONSTRAINTS

With respect to any given problem involving the necessity of coming to a decision, there are typically many desirable behavior alternatives from among which a choice might be made. But, for reasons to be discussed below, the individual who must make the decision is not always free to choose from among all these desirable behavior alternatives. Some of them may be excluded, by one means or another, from his range of choice. It is only from among those alternatives which remain—the available alternatives—that a choice may be made.

In the discussion which follows, it will be said that an individual exercises discretion with respect to available alternatives, since discretion is the power of free decision, of undirected choice. And the available alternatives pertinent to any given decision will be considered as falling

[7] No available term is completely satisfactory to connote the meaning here intended. The term used seems most closely to conform to that meaning.

within a sphere of discretion. For each problem calling for decision, there is such a sphere. A sphere of discretion has limits within which the exercise of discretion is confined. Those factors which set the limits to spheres of discretion—which restrict, restrain, or limit the exercise of discretion to available alternatives—will be referred to as "constraints." The types of constraints which thus define spheres of discretion are numerous and call for more detailed attention.

1. Authoritative constraints.—A subordinate may have designated for him by his superior certain behavior alternatives which cannot be considered by him in the making of a given decision. Thus a salesman might be told by his superiors that all sales made of a given item must be made at a price falling within a specified range. Within that range the salesman may exercise discretion. Of all the constraints, the authoritative is the only one that is personal in nature—that is imposed by one or more individuals on another.

2. Biological constraints.—When a decision is being made which will directly affect the behavior of the individual making the decision or the behavior of another, the sphere of discretion of the decision-maker can be constrained by certain biological characteristics of himself or of the other individual, as the case may be. These characteristics may be permanent in nature (a human being cannot fly), or they may be temporary and therefore subject to change (a person may not now know how to operate a lathe, but he may be able to learn to do so).

3. Physical constraints.—The constraints of the physical environment are ever present. They include such factors as geography, climate, physical resources, man-made objects, the chemical elements, as well as physical and chemical laws. These factors are typically important in defining spheres of discretion.

4. Technological constraints.—These constraints are determined by the state of the arts. For example, in determining how to make a given product, the decision-maker is limited in his choice to those alternatives which are technologically possible.[8]

5. Economic constraints.—In a freely competitive economic system, prices of products and of productive services are impersonally determined through the operation of market forces. To the individual or business enterprise in the system, these prices are "givens." The same is true of consumer wants. These "givens" are constraints with respect to economic decisions relating to maximization. Furthermore, the economic resources available to an individual or an enterprise are often also important economic constraints in decision-making.

These types of constraints, where relevant, define spheres of discretion. They determine those behavior alternatives which are not available for

[8] Of course, he may attempt to extend the state of the arts, but such an extension involves a different kind of problem.

choice. It is from among those alternatives which remain—the available alternatives—that a choice is made. Decision-making, then, is judgment exercised within constraints.

WAYS IN WHICH THE BEHAVIOR OF ONE CAN BE DIRECTLY AFFECTED BY THE DECISIONS OF ANOTHER

In the preceding section dealing with authority, it was stated that authority is used by a superior directly to affect the behavior of a subordinate. The ways in which a superior can so affect the behavior of a subordinate can now be considered.

1. The superior can impose constraints on a sphere of discretion of a subordinate as discussed above, thereby limiting the subordinate's discretion to the behavior alternatives which remain.

2. The superior can completely eliminate spheres of discretion from the province of a subordinate. In this case the subordinate is permitted no discretion with respect to the given problems, and no behavior is expected of him with respect to them.

3. The superior can impose a decision on the subordinate to the effect that the subordinate act in a particular manner. Here, again, no discretion with respect to the problem is permitted to the subordinate, but specified behavior (including forbearance) is expected of him.

Each of these devices which might be used by a superior stems from a decision made by him and results in some direct effect upon his subordinate's behavior.

THE MANAGED AND DECISION-MAKING

INTRODUCTION

It has previously been pointed out that managers make decisions to affect, both directly (through authority) and indirectly (through influence), the behavior of their subordinates. In this section consideration will be given to the implications of these managerial decisions to the behavior of the subordinates—the managed.

It has been seen that the relatively isolated individual is faced with insurmountable difficulties in his attempt to achieve rational behavior. But when individuals become members of organized groups, it is at least possible for their behavior to achieve a high degree of rationality when viewed in terms of group purposes. The decisions of managers, operating upon the managed through authority and influence, make this possible in ways which will be examined below.

In the discussion which follows, it will be important to remember that the term "managed" includes most managers and all nonmanagers. A

manager is such only with respect to his subordinates; he is managed with respect to his superior. Of all the managers in an enterprise, only the head of the supreme complex is a manager who is not at the same time being managed. The concern in this section is with the managed as such, including individuals who are both managers and nonmanagers.

THE BEHAVIOR OF THE MANAGED AS AFFECTED BY MANAGERIAL DECISIONS

The decisions of managers (made to organize, direct, or control responsible subordinates) operate to increase the rationality of the behavior of subordinates—when viewed in terms of enterprise purposes—in the following ways.

1. Decisions are made by superiors which define enterprise purpose. This purpose is the end for the attainment of which the specialized services of the members of the group are being contributed. It is important that the decisions made by each member of the group be made with reference to the group end and not a differing personal end. Through training it is possible to indoctrinate individuals in the enterprise purpose; through incentives, to induce individuals to accept it; and through supervision, to insure that the enterprise purpose will guide individual decisions.

2. Superiors establish the criterion of rationality to guide subordinates in making the choices which they are called upon to make. It will be remembered that this criterion requires that a choice be made between alternatives which will maximize results (the degree of attainment of the relevant end) at a given cost. For a business firm seeking to maximize profits, this cost is a money cost. As in the preceding case, training, incentives, and supervision are the relevant managerial devices to be used in establishing the criterion of rationality as the basis for individual choice.

3. In establishing the degree and type of specialization to be effectuated within an enterprise, superiors thereby define the general kind of activity to be expected of individuals filling particular positions. Such definition significantly reduces the number of spheres of discretion which are relevant to the particular activity to which an individual is assigned. This limitation is an aspect of the managerial function of organization.

4. Another relevant aspect of the function of organization is the determination of lines of formal authority. This determination establishes for the subordinate the individual (or individuals) to whom he is to look for decisions made to affect his behavior.

5. With respect to those spheres of discretion relating to the general kind of activity expected of a subordinate, superiors frequently impose additional constraints, thereby limiting the number of available behavior alternatives from among which the subordinate is expected to choose.

6. Superiors can provide subordinates with relevant information. This information may relate to behavior alternatives about which the subordinate is not aware. Or it may relate to the consequences attendant upon specific behavior alternatives. This information may be supplied through training, through the use of reports and memoranda, through conversation, and the like.

7. Superiors may request that particular decisions be made at or by a specified time. Such requests are stimuli which direct the attention of subordinates to designated problems and therefore initiate the decision-making processes at particular moments of time.

8. With respect to given problem areas, superiors may expect specific behavior responses of their subordinates which permit no discretion to them. Here the subordinate is not expected to make a decision to guide his own behavior but simply to act in the manner specified by his superior. The superior may specify the action of the subordinate through an on-the-spot order; or he may use such devices as rules, regulations, routines, standing orders, policies, standard methods and procedures, and the like to accomplish the same purpose. In this connection it should be noted that the same purpose can also be accomplished by selecting people with desired attributes or by training them. Through selection or training, particular individual modes of response can reasonably be insured so that the number of direct orders which must be given can be reduced. Thus, if a novice is hired to do clerical work, his superior must specifically tell him what to do, how to do it, etc. But if a trained person is hired or the novice is trained, then such specific orders are no longer necessary.

In the summary, the subordinate (the individual managed) is expected to focus his attention on a greatly restricted number of problems calling for decision. With respect to these problems, authoritative constraints are often imposed on the pertinent spheres of discretion which further limit his range of choice. Information is provided which calls the subordinate's attention to behavior alternatives relevant to particular decisions and which adds to his knowledge of the consequences attendant upon those behavior alternatives under consideration. The ends toward which his decisions must be directed are specified for him, as is the criterion of rationality to guide the choices which he must make. Lines of formal authority are specified for him which designate the individual (or individuals) to whom he is to look for decisions to affect his behavior. His superior often determines for him the particular problems calling for his decision to which he should direct his attention at specified moments of time. The superior often expects specific behavior responses of the subordinate which permit no discretion to him. And through incentives and supervision the superior reasonably insures that all the behavior responses of the subordinate are in conformance with those desired. As a result of

these factors which originate with superiors, it is possible for the behavior of the subordinate to achieve a high degree of rationality when viewed in terms of enterprise purposes.

THE MANAGERS AND DECISION-MAKING

INTRODUCTION

The decisions of managers are made to affect the behavior of responsible subordinates in the ways considered in the preceding section. But these decisions are themselves not made in a vacuum. They are subject to all the restrictions which have previously been discussed and to influence. In this section, particular attention will be given to the sources from which stem the authority and influence which can directly and indirectly affect the managerial decision-making process.

AUTHORITY AND THE DECISIONS OF MANAGERS

In making decisions, managers can be subject to the authority of many individuals and groups. The determination as to whether they will be subject to such authority, of course, always rests with the managers. They, like others, can either accept or reject any exercise of authority. If they accept the exercise of authority (because of positive inducements or coercion), they thereby assume a role of subordination with respect to the individuals or group possessing the authority. The superior can directly affect the behavior of the subordinate in the ways previously discussed—by imposing constraints on spheres of discretion, by completely eliminating spheres of discretion from the province of the subordinate, and by imposing a decision on the subordinate to the effect that the subordinate act in a particular manner.

There are many individuals and groups who do, at varying times, exercise authority with respect to managers. While no attempt will be made in the discussion which follows to consider all those who might authoritatively impinge upon managers, the principal ones will be given attention.

First, nearly all managers, as managed, are subject to the authority of their managerial superiors. This relationship was probed in the preceding section. At this point it is simply necessary to point out that this exercise of authority directly affects, among other things, the decisions made by the subordinate manager to affect the behavior of his own subordinates.

Second, managers are subject to the authority of individuals who, from the formal point of view, are their own subordinates. At first glance, this may be difficult to visualize, but it is a fact the understanding of which is crucial to the effective performance of the functions of management.

It has previously been stated that the sphere of authority possessed by a superior is defined for him by the sphere of acceptance of his subordinates. It is likewise true that the sphere of nonacceptance of authority of formal subordinates defines the sphere of nonauthority of the formal superior. This limiting effect imposed upon the managerial decision-making process by formal subordinates is indeed real.

One of the arts of leadership is that of widening the sphere of acceptance of formal subordinates and, therefore, the sphere of authority of the leader.

Third, managers are subject to the authority of individuals and groups who are not members of the formal organization of the enterprise. Among these are the following:

1. Governmental agencies: local, state, and federal.—Government agencies impinge upon the decision-making processes of management through the adoption of constitutions or charters, the passage of legislation, the interpretation of legislation by the courts, and the action of administrative bodies. They establish the rules of the game (the institutional framework within which enterprises operate), impose restrictions, demand specific action, settle disputes, and approve certain managerial decisions before these can become effective.

2. Parties to contracts with management.—When management enters into a contract with another party (an act involving the acceptance of the authority of another), it thereby agrees to meet certain obligations or to accept certain restrictions upon its activities.

3. Monopolistic and monopsonistic economic groups.—In those areas of economic activity where conditions of perfect competition do not exist, buyers of the enterprise's products and sellers to the enterprise of productive services are often able, through the use of monopsonistic and monopolistic power, respectively, directly to affect the behavior of managers. Among the monopsonists are consumer's organizations and large private buyers of the products of the enterprise. Among the monopolists are large suppliers of capital funds (banks, bondholders, etc.), raw materials, and labor services (unions).[9]

Because of the growing importance of unions in relation to managers, it is desirable to give additional attention to these monopolistic groups. The kinds of restrictions and the demands for particular actions which they impose upon managers are numerous. And they often impose these restrictions and demands through the threat or use of coercive economic power. It has previously been stated that managers are subject to the authority of individuals who, from the formal point of view, are their own

[9] I recognize that these monopolists and monopsonists are often parties to contracts with management. However, managers also often become subject to their authority where contractual relationships are not involved.

subordinates. In this case the limitations to the exercise of managerial authority are imposed by isolated individuals and informal groups. These same individuals, by joining together in unions, can impose the limitations much more effectively because of the coercive power available to strong, formal groups. Finally, in this connection, it should be pointed out that, although coercion is an important device of the union in obtaining managerial acceptance of its exercise of authority, positive inducements are also used. For example, a union may offer something of value to managers in return for an accepted limitation of managerial authority.

4. Arbitrators.—When managers accept arbitration as a means for the settlement of a dispute (labor or otherwise) to which the enterprise is a party, they thereby assume a role of subordination with respect to the arbitrator.

5. Cartels, trade-associations, and other business associations.—Enterprises often are members of one or more such business associations. Decisions are frequently made in these associations which are accepted as being authoritative by the managers of the member enterprises.

6. The general social order.—The decisions of managers are always subject to the general social order. Custom, tradition, convention, mores, and the like are the relevant authoritative principles; and sanctions (both positive and negative) are the factors which determine managerial acceptance or rejection of the authority.

Authority exercised by these individuals and groups, external to the enterprise, is always an extremely important factor in the direct determination of the behavior of the managers of the enterprise.

INFLUENCE AND THE DECISIONS OF MANAGERS

In making decisions, managers can also be indirectly affected by the influence of many individuals and groups. The information supplied by these individuals and groups can add to or change the relevant factors (means or ends) which managers otherwise would take into account in arriving at decisions. It must be remembered that the individual or group which exercises influence may offer advice, make suggestions, enter into discussions, use propaganda and the like; but they do not thereby exercise authority.

As in the case of authority, there are individuals who are members of the formal organization of the enterprise who exercise influence with respect to managers. First, nearly all managers, as managed, are subject to the influence of their managerial superiors. This relationship, also, was probed in the preceding section. What is important here is that this exercise of influence indirectly affects, among other things, the decisions made by the subordinate manager to affect the behavior of his own subordinates. Second, managers are subject to the influence of their subordinates.

In this connection, it is useful to see that a manager can subdivide the work related to the decisions which he must make, holding subordinates responsible for the making of preliminary decisions (involving recommendations to him) which enter into his making of the final decision. In this manner the manager can be provided with information with respect both to relevant behavior alternatives and to the consequences attendant upon specific behavior alternatives. The organizational device of the staff is a specialized unit whose function is to provide information to the manager to whom it is attached.[10] Through the channels of upward communication and such devices as suggestion systems, information also flows to managers.

Many individuals and groups who are not members of the formal organization of the enterprise also exercise influence with respect to managers. These include, among others, governmental agencies; suppliers of productive services; customers; cartels, trade-associations, and other business associations; and consultants (including accountants, lawyers, engineers, and similar specialists). Few decisions are made by managers which are not indirectly affected by the influence of such individuals and groups.

MANAGERS AND REGULATORS DIFFERENTIATED

It was concluded that managers are those who use formal authority to organize, direct, or control responsible subordinates in order that all service contributions be co-ordinated in the attainment of an enterprise purpose. The use of formal authority for these purposes is the essence of management.

The practice is currently prevalent on the part of many writers and speakers to refer to individuals and groups (external to the formal organization of the enterprise), who exercise authority and influence with respect to the managers of the enterprise, as participating or sharing in management. These individuals and groups do not participate or share in management, and they are not managers (except, perhaps, of the enterprises to which they belong). They regulate managers (through authority

[10] Lewis C. Sorrell has commented upon this fact, as follows: "While much confusion obtains regarding the proper functioning of a staff in business concerns . . . , essentially it is coming to mean one or more persons charged with the responsibility of ascertaining the important trends internal and external to the business, determining their incidence upon the enterprise or some important division thereof, observing the methods employed by others for coping with similar situations, selecting the several alternatives of policy that appear to be most practical under all the circumstances, and presenting all this to the proper executives—but without authority to direct or order anything into execution" ("The Role of Management in the Organization of Resources for Production," *Management's Adjustment to the Changing National Economy*, ed. William N. Mitchell [Chicago: University of Chicago Press, 1942], p. 37).

and influence), but they do not manage.[11] In the present writer's view, if one attempted a definition of the manager broad enough to include these individuals and groups (the regulators), the result would be a concept of the manager which would be so lacking in content and sharpness as to be of little theoretical or practical value.

The point is simply this: Managers head groups (either of other managers or of nonmanagers) in formal systems of co-ordination. They use formal authority to manage responsible subordinates. The individuals comprising each group are guided by an enterprise purpose, and their specialized service contributions are co-ordinated by their manager in the attainment of that purpose. On the other hand, the regulators, who are external to the formal organization of the enterprise, are not a part of the formal system of co-ordination. They use authority (but not formal authority) and influence to regulate (i.e., directly and indirectly to affect) the behavior of others. They and the managers are not guided by the same purpose, nor is co-ordination of specialized service-contributions toward the attainment of an enterprise purpose involved in the relationship between them.

To differentiate clearly between managers and regulators is to provide an extremely useful frame of reference for dealing with many problems, including those of public policy. To fail to make the differentiation can lead to confusion and misunderstanding, the effects of which, in this writer's judgment, can only be an incorrect approach to those problems.

13. OBSERVATION OF A BUSINESS DECISION

Richard M. Cyert, Herbert A. Simon, and Donald B. Trow*

The authors have dissected an actual major business decision for the purposes of evaluating traditional assumptions regarding business decision-making. The example chosen concerned itself with the feasibility of using electronic data-processing equipment and is omitted in order to emphasize the conclusions reached by the authors.

Decision-making—choosing one course of action rather than another, finding an appropriate solution to a new problem posed by a changing world—is commonly asserted to be the heart of executive activity in busi-

[11] The term "control" would be preferable, in this connection, to the term "regulate." I do not here use the former term, since it has been used above with another connotation.

* From *Journal of Business*, XXIX, 4 (1956), 237-48. Reprinted by permission of the University of Chicago Press.

ness. If this is so, a realistic description and theory of the decision-making process are of central importance to business administration and organization theory. Moreover, it is extremely doubtful whether the only considerable body of decision-making theory that has been available in the past—that provided by economics—does in fact provide a realistic account of decision-making in large organizations operating in a complex world.

In economics and statistics the rational choice process is described somewhat as follows:

1. An individual is confronted with a number of different, specified alternative courses of action.

2. To each of these alternatives is attached a set of consequences that will ensue if that alternative is chosen.

3. The individual has a system of preferences or "utilities" that permit him to rank all sets of consequences according to preference and to choose that alternative that has the preferred consequences. In the case of business decisions the criterion for ranking is generally assumed to be profit.

If we try to use this framework to describe how real human beings go about making choices in a real world, we soon recognize that we need to incorporate in our description of the choice process several elements that are missing from the economic model:

1. The alternatives are not usually "given" but must be sought, and hence it is necessary to include the *search for alternatives* as an important part of the process.

2. The information as to what consequences are attached to which alternatives is seldom a "given," but, instead, the search for consequences is another important segment of the decision-making task.

3. The comparisons among alternatives are not usually made in terms of simple, single criterion like profit. One reason is that there are often important consequences that are so intangible as to make an evaluation in terms of profit difficult or impossible. In place of searching for the "best" alternative, the decision-maker is usually concerned with finding a *satisfactory alternative*—one that will attain a specified goal and at the same time satisfy a number of auxiliary conditions.

4. Often, in the real world, the problem itself is not a "given," but, instead, searching for significant problems to which organizational attention should be turned becomes an important organizational task.

Decisions in organizations vary widely with respect to the extent to which the decision-making process is *programmed*. At one extreme we have repetitive, well-defined problems (e.g., quality control or production lot-size problems) involving tangible considerations, to which the economic models that call for finding the best among a set of pre-established alternatives can be applied rather literally. In contrast to these highly programmed and usually rather detailed decisions are problems of a non-

repetitive sort, often involving basic long-range questions about the whole strategy of the firm or some part of it, arising initially in a highly unstructured form and requiring a great deal of the kinds of search processes listed above. In this whole continuum, from great specificity and repetition to extreme vagueness and uniqueness, we will call decisions that lie toward the former extreme *programmed*, and those lying toward the latter end *non-programmed*. This simple dichotomy is just a shorthand for the range of possibilities we have indicated.

It is our *aim* in the present paper to illustrate the distinctions we have introduced between the traditional theory of decision, which appears applicable only to highly programmed decision problems, and a revised theory, which will have to take account of the search processes and other information processes that are so prominent in and characteristic of non-programmed decision-making. We shall do this by recounting the stages through which an actual problem proceeded in an actual company and then commenting upon the significance of various items in this narrative for future decision-making theory.

The decision was captured and recorded by securing the company's permission to have a member of the research team present as an observer in the company's offices on substantially a full-time basis during the most active phases of the decision process. The observer spent most of his time with the executive who had been assigned the principal responsibility for handling this particular problem. In addition, he had full access to the files for information about events that preceded his period of observation and also interviewed all the participants who were involved to a major degree in the decision.

THE ELECTRONIC DATA-PROCESSING DECISION

The decision process to be described here concerns the feasibility of using electronic data-processing equipment in a medium size corporation that engages both in manufacturing and in selling through its own widely scattered outlets. In July, 1952, the company's controller assigned to Ronald Middleton, an assistant who was handling several special studies in the accounting department, the task of keeping abreast of electronic developments. The controller, and other accounting executives, thought that some of the current developments in electronic equipment might have application to the company's accounting processes. He gave Middleton the task of investigation, because the latter had a good background for understanding the technical aspects of computers.[1]

[1] The "recounting of the stages" of the problem follows this point in the article, but it is omitted here in order to conserve space. The discussion which follows is relevant generally and is not dependent on the actual case illustration.

THE ANATOMY OF THE DECISION

From this narrative, or more specifically from the actual data on which the narrative is based, one can list chronologically the various activities of which the decision process is composed. If we wish to describe a program for making a decision of this kind, each of these activities might be taken as one of the steps of the program. If the rules that determine when action would switch from one program step to another were specified, and if the program steps were described in enough detail, it would be possible to replicate the decision process.

The program steps taken together define in retrospect, then, a program for an originally unprogrammed decision. The program would be an inefficient one because it would contain all the false starts and blind alleys of the original process, and some of these could presumably be avoided if the process were repeated. However, describing the process that took place in terms of such a program is a useful way of organizing the data for purposes of analysis.

In order to make very specific what is meant here by a "program," Chart I has been prepared to show the broad outlines of the actual program for the first stages of the decision process (through the first seven paragraphs of the narrative).

CHART I

PROGRAM STEPS FROM INCEPTION OF THE PROBLEM TO SELECTION OF A CONSULTANT

Keeping-up program (paragraphs 1 and 2 of narrative):
- Search for and correspond with experts;
- Discuss with salesmen and with equipment users;
- Search for and read journals;

Procurement program (paragraph 3):
- Discuss applications study with salesmen who propose it;
- Choice: accept or reject proposed study;
- (If accepted) transfer control to salesmen;
- Choice: accept or reject applications proposal;
- (If rejected) switch to consultant program;

Consultant program (paragraphs 4 through 7):
- Search for consultants;
- Choice: best consultant of several;
- Transfer control to chosen consultant;
- Choice: accept or reject proposal;
- (If accepted): begin double-check routine;
- Request expenditure of funds;
- (If authorized) transfer control to consultants;
- And so on.

SUBPROGRAMS

The various program steps of the decision process fall into several subprograms, some of which have been indicated in Chart I. These subprograms are ways of organizing the activities *post factum*, and in Chart I the organizing principle is the method of approach taken by the company to the total problem. It remains a question as to whether this organizing principle will be useful in all cases. As in the present example, these subprograms may sometimes be false starts, but these must be regarded as parts of the total program, for they may contribute information for later use, and their outcomes determine the switching of activity to new subprograms.

In this particular case the reasons for switching from one subprogram to another were either the proved inadequacy of the first one or a redefinition of the problem. Other reasons for switching can be imagined, and a complete theory of the decision process will have to specify the conditions under which the switch from one line of attack to another will occur.

COMMON PROCESSES

In the whole decision-making program there are certain steps or "*routines*" that recur within several of the subprograms; they represent the basic activities of which the whole decision process is composed. For purposes of discussion we have classified these common processes in two categories: the first comprises processes relating to the communication requirements of the organization; the second comprises processes relating directly to the solution of the decisional problem.

COMMUNICATION PROCESSES

Organizational decision-making requires a variety of communication activities that are absent when a decision is made in a single human head. If we had written out the program steps in greater detail, many more instances of contacts among different members of the organization would be recorded than are now explicit in the narrative. The contacts may be oral or written. *Oral contacts* are used for such purposes as giving orders, transmitting information, obtaining approval or criticism of proposed action; *written communications* generally take the form of memorandums having the purpose of transmitting information or proposing action.

The information-transmitting function is crucial to organizational decision-making, for it almost always involves acts of selection or "filtering" by the information source. In the present instance, which is rather typical

in this respect, the consultants and subordinate executives are principal information sources; and the controller and other top executives must depend upon them for most of their technical information. Hence, the *subordinate acts as an information filter* and in this way secures a *large influence* over the decisions the superior can and does reach.

The influence of the information source over communications is partly controlled by checking processes—for example, retaining an independent expert to check consultants which give the recipient an independent information source. This reduces, but by no means eliminates, filtering. The great differences in the amounts and kinds of information available to the various participants in the decision process described here emphasize the significance of filtering. It will be important to determine the relationship of the characteristics of the information to the resultant information change and to explore the effects of personal relations between people on the filtering process and hence upon the transmission of information.

PROBLEM-SOLVING PROCESSES

Alongside the organizational communication processes, we find in the narrative a number of important processes directed toward the decision problem itself. One of the most prominent of these is the *search for alternative courses of action.* The first activities recounted in the narrative—writing letters, reading journals, and so on—were attempts to discover possible action alternatives. At subsequent points in the process searches were conducted to obtain lists of qualified consultants and experts. In addition to these, there were numerous searches—most of them only implicit in the condensed narrative—to find action alternatives that would overcome specific difficulties that emerged as detail was added to the broader alternatives.

The data support strongly the assertion made in the introduction that searches for alternative courses of action constitute a significant part of non-programmed decision-making—a part that is neglected by the classical theory of rational choice. In the present case the only alternatives that became available to the company without the expenditure of time and effort were the systems proposals made early in the process by representatives of two equipment companies, and these were both rejected. An important reason for the *prominent role of search in the decision process* is that the "problem" to be solved was in fact a whole series of "nested" problems, each alternative solution to a problem at one level leading to a new set of problems at the next level. In addition, the process of solving the substantive problems created many procedural problems for the organization: allocating time and work, planning agendas and report presentations, and so on.

Examination of the narrative shows that there is a rich variety of search processes. Many questions remain to be answered as to what determines the particular character of the search at a particular stage in the decision process: the possible differences between searches for procedural alternatives, on the one hand, and for substantive alternatives, on the other; the factors that determine how many alternatives will be sought before a choice is made; the conditions under which an alternative that has tentatively been chosen will be subjected to further check; the general types of search strategies.

The neglect of the search for alternatives in the classical theory of decision would be inconsequential if the search were so extensive that most of the alternatives available "in principle" were generally discovered and considered. In that case the search process would have no influence upon the alternative finally selected for action. The narrative suggests that this is very far from the truth—that, in fact, the *search for alternatives terminates when a satisfactory solution has been discovered even though the field of possibilities has not been exhausted.* Hence, we have reason to suppose that changes in the search process or its outcome will actually have major effects on the final decision.

A second class of common processes encompasses *information-gathering* and similar activity *aimed at determining the consequences of each of several alternatives.* In many decisions, certainly in the one we observed, these activities account for the largest share of man-hours, and it is through them that subproblems are discovered. The narrative suggests that there is an inverse relation between the cost or difficulty of this investigational task and the number of alternative courses of action that are examined carefully. Further work will be needed to determine if this relation holds up in a broader range of situations. The record also raises numerous questions about the *kinds* of consequences that are examined most closely or at all and about the conditions under which selection of criteria for choice is prior to, or subsequent to, the examination of consequences.

Another set of common processes are those concerned with the *choices among alternatives.* Such processes appear at many points in the narrative: the selection of a particular consulting firm from a list, the choice between centralized and decentralized electronic-data-processing systems, as well as numerous more detailed choices. These are the processes most closely allied to the classical theory of choice, but even here it is notable that traditional kinds of "*maximizing*" *procedures* appear only *rarely.*

In some situations the choice is between competing alternatives, but in many others it is one of acceptance or rejection of a single course of action—really a *choice between doing something at this time and doing nothing.* The first such occasion was the decision by the controller to

assign Middleton to the task of watching developments in electronics, a decision that initiated the whole sequence of later choices. In decisions of this type the consequences of the single alternative are judged against some kind of explicit or implicit "*level of aspiration*"—perhaps expressed in terms of an amount of improvement over the existing situation—while in the *multiple-alternative situations*, the *consequences of the several alternatives are compared with each other.* This observation raises a host of new questions relating to the circumstances under which the decision will be formulated in terms of the one or the other of these frameworks and the personal and organizational factors that determine the aspiration levels that will be applied in the one-alternative case.

Another observation derivable from our data—though it is not obvious from the condensed narrative given here—is that *comparability and non-comparability of the criteria of choice affects the decision processes* in significant ways. For one thing, the criteria are not the same from one choice to another: one choice may be made on the basis of relative costs and savings, while the next may be based entirely on non-monetary criteria. Further, *few*, if any, *of the choices* were *based on a single criterion.* Middleton and the others recognized and struggled with this problem of comparing consequences that were sometimes measured in different, and incomparable units, and even more often involved completely intangible considerations. The narrative raises, but does not answer, the question of how choices are made in the face of these incommensurabilities and the degree to which tangible considerations are overemphasized or underemphasized as compared with intangibles as a result.

CONCLUSION

We do not wish to try to transform one swallow into a summer by generalizing too far from a single example of a decision process. We have tried to illustrate, however, using a large *relatively non-programmed decision in a business firm,* some of the processes that are involved in business decision-making and to indicate the sort of theory of the choice mechanism that is needed to accommodate these processes. Our illustration suggests that *search processes and information-gathering processes* constitute significant parts of decision-making and must be incorporated in a theory of decision if it is to be adequate. While the framework employed here—and particularly the analysis of a decision in terms of a hierarchical structure of *programs*—is far from a complete or finished theory, it appears to provide a useful technique of analysis for researchers interested in the theory of decision as well as for business executives who may wish to review the decision-making procedures of their own companies.

14. MATHEMATICS FOR DECISION-MAKERS

R. K. Gaumnitz and O. H. Brownlee*

The authors take note of the impact of the electronic computer on data manipulation and the increasing application of mathematics to administrative problems involving decisions. The authors draw the conclusion that the decision-maker does not have to be a mathematician to make effective use of mathematical techniques or electronic computers, but they also note that the resulting lack of easy communication between the decision-maker and the mathematician may make co-operation difficult and even hazardous.

Business executives recently have been flooded with descriptions of the wonders that can be performed with the aid of such devices or techniques as electronic computers, mathematical programing (linear programing and some aspects of operations research, for example), and servomechanisms or information theory. Some of these are the result of refinements in devices and techniques that have been used or known for a relatively long time. Others are relatively new. All of them require fairly extensive knowledge of certain branches of mathematics, on the part of *someone*, in order that they can be thoroughly understood and operated to advantage.

Does this mean that mastery of calculus, matrix algebra, probability theory, and topology is becoming a management prerequisite? *Definitely no.* Does it mean that the top executives of tomorrow must be better skilled in fundamental operations like calculating percentages and working out equations? *Not necessarily.* Does it mean that more understanding of the mathematical approach to problems will be useful to the man who makes important business decisions? *Unqualifiedly yes.*

The recent developments in this field do not change the basic character of the decision making that the businessman must do. Rather, they permit more rigorous formulation of the problems he faces, facilitate the figuring of possible situations for him to consider, and add explicitness and quantification to the terms in which he frames his decisions. At the same time, it cannot be denied that a top executive would benefit from knowledge of certain kinds of mathematics. This has always been true. The only difference is that now, because of the technical advances that have been made, the task of understanding and communicating is more difficult and the potential of usefulness is richer.

* From *Harvard Business Review*, XXXIV, 3 (1956), 48-56. Reprinted by permission of the *Harvard Business Review*.

The real question of the moment is *how much* knowledge the executive should have in view of (a) what it can contribute and (b) what is entailed in acquiring it.

NEW DEVELOPMENTS

Some of the new developments have been responsible for considerable speculation and comment about the importance of mathematics to management. How much difference will they actually make as their use becomes more and more widespread?

ELECTRONIC COMPUTERS

One may distinguish two general types of situations involving electronic computers: (1) the transfer to computers of work now performed by clerks or by lower order machines (i.e., machines that are slower and lack "memories"); and (2) the use of modern machines or methods to carry out clerical jobs not previously undertaken at all because of the difficulty of doing so by conventional methods.

In the first instance, all that the computer or the data-processing device does is to perform routine clerical operations more efficiently than has been possible without the aid of such a machine. Thus, for instance, computers and other electronic equipment may process certain insurance or public utility billing data much less expensively and/or at greater speed than is possible with traditional methods and machines.

Here it is clear that the top executive, at least, needs no special training in mathematics to benefit from the use of such equipment. While someone in the organization surely will have to know a great deal about how to instruct and operate the electronic equipment, there is no more reason for the executive to be informed of the details of this than for him to know how to operate a new folding machine that will speed mass mailing. These are matters for technicians, not executives.

In the second instance, some problems that are not solved at present, simply because the time required (or the cost involved) is too great if traditional equipment and techniques are used, become economically feasible by using computers and other electronic equipment.

Substantial reductions in cost are sometimes more important than the time-saving illustrated above. Thus, if clerks cost only $20 per year, certain sales analyses would be performed in many firms; utilizing modern calculating equipment may actually achieve the equivalent of this low price for such work.

Here again the executive need have no special knowledge of mathematics to benefit from the new equipment. However, he knows best what

would be useful to him in making decisions; and if he has some understanding of the practicability of different statistical manipulations, he will be in a better position to identify his needs and get them served.

LINEAR PROGRAMING

From the standpoint of the business executive, the new techniques for stating and solving problems are like computing machines in that they too make it possible to solve some problems much more readily than could be done before. Linear programing is one of the techniques and it can serve to illustrate the extent of mathematical knowledge needed by the executive:

No special mathematical training is required to understand the results of typical applications of linear programing or, for that matter, to understand what is involved in it.

Frequently solution by linear programing methods requires, as a practical matter, access to an electronic computer. But essentially the technique does nothing that could not be done, given enough time and enough clerks, with the use of simple mathematical techniques or ordinary mechanical computers.

What the technique does is to make possible more rapid solutions of certain problems, particularly those where choices must be made from among a large number of alternative courses of action, some of which may be more attractive than others in terms of higher profit, lower cost, or some other characteristic. In other words, it simply systematizes and makes efficient the process of identifying the most attractive course or courses of action.

Why the technique works, and *how* it works, is not vital information for the executive. What matters to him is that the technique *does* identify the best solution. Rather than being capable of performing the necessary computations, he needs to be able to communicate with the experts about the problems on which they can help him.

Techniques also are being developed for solving selected scheduling problems more efficiently—for example, the order in which products should be manufactured with available labor and equipment. The relation of the executive to these techniques parallels his relationship to linear programing, in that he requires understanding of the general approaches, rather than special mathematical knowledge, in order that his company may enjoy some of the benefits of the new procedures.

POTENTIAL USES

While the executive need not understand the basic principles underlying an electronic computer or how to operate it, and need not know why and

how techniques such as linear programing work, there is still a lot that he needs to know about mathematics—perhaps not so much more in quantity than in the past, but of a different kind.

Mathematics can be viewed as a language that is particularly useful in formulating certain types of problems, because it focuses on only the essential factors and their logical relationships. Thus, it is a language that makes it easier for a person to see the implications of certain kinds of actions. Undoubtedly there are, and will be, successful executives who know little or no mathematics or who never use mathematical notation in their thinking. But a person of given intelligence can see certain problems more clearly and solve them more readily with the aid of mathematics.

Among the classes of problems that one can think about efficiently in the mathematical language—i.e., formulate and solve—are certain business problems commonly presented for executive decision. Such problems typically require finding an optimum—usually a maximum or a minimum—from among a number of possible values. Examples are the problems of minimizing the cost of producing a given output, choosing a collection of products that will maximize revenue, arriving at a price or markup for a product, and selecting the amount of advertising outlay for each of a number of different media. Merely identifying a problem as one of maximum or minimum values frequently helps to clarify it.

Also, the implications of certain actions can be perceived more readily when problems are recognized as problems of maxima and minima. For example:

> Some businessmen seem to be overimpressed with the fact that a large volume of production means a relatively low per unit overhead cost—the desirability of "spreading the overhead."
>
> Actually it is only the *changes* in total cost and total revenue that should determine whether output should be changed. The objective is to *maximize the difference* between total revenue and total cost. Changes in total cost are not affected by the level of fixed costs and therefore "overhead" items are irrelevant except when deciding whether to produce at all.
>
> The above relationships have not been universally appreciated by business executives; some of this lack of perception may be due to traditional accounting methods and concepts. But persons who are able to describe revenue and cost algebraically as they are related to output, and who possess even a vague familiarity with the calculus, would not be expected to make such an error.

It frequently is desirable for an executive to examine problems in quantitative form. The habit of thinking in quantitative terms has been acquired by some people with little mathematical training. Using the "sharp pencil" approach to many problems often characterizes successful executives. Insofar as mathematical training strengthens and extends this approach, it will aid in making effective decisions.

Thinking in quantitative terms is commonplace where the factors to be considered are expressed as numbers—wage rates, man-hours, raw materials, costs, transportation charges, and so on—which in turn are used to

obtain total cost, total receipts, profits, or some other figure of interest. However, there are other situations where the variables are not so readily measured but where quantification is still possible and might lead to more reasonable decisions than those reached with only vague quantification. For example:

Deciding whether to employ a more accurate but more costly price or sales forecasting procedure requires assigning a schedule of values to greater accuracy.

Or making a sensible decision between (a) shipping an uninspected product and taking a chance that some customers may receive an unsatisfactory item and (b) shipping a product late but properly inspected, which would probably involve an explicit evaluation of possible losses from the alternative courses of action.

The outcomes of most business problems are not certain; some, however, can be described in probability terms. One usually cannot determine exactly what output will be produced by a given number of men and a given number of machines, by what amount total sales will change as a result of a particular advertising campaign, or what price will be paid for a certain raw material or be received for a particular kind of product. However, it is sometimes helpful to make some kind of probability statements about such phenomena. For instance:

"The chances are three out of four that the price will be between $8 and $9."

"The chances are nine out of ten that the per acre corn yield will be less than 60 bushels."

"We have better than a 50-50 chance of cracking the cat food market by this campaign."

Some understanding of probabilities is particularly useful in making decisions based on price forecasting, quality control, or inventory control procedures. Without it there can be trouble. Quite a few businessmen think that if the chances are one out of three that a certain desired result will ensue, a person can be sure of achieving it in three tries. But actually what the statement means is that the likelihood of the event not happening is twice as great as the likelihood of its happening, and the implication *for the businessman* might be that he had better not undertake the risk unless he can withstand the cost of failure.

COMMUNICATION

Let us take for granted that the executive is not the person who performs the calculations, writes elaborate equations, expresses inequalities, and so on; and that he has access to people who are trained in the relevant mathematics—if, indeed, mathematical formulations and analytical methods are to be employed on any sizable scale. On this basis, there is obviously a problem of communication between the executive and the technician.

The extent of the difficulty here depends on the intelligence and breadth of knowledge of both the technician and the executive involved. If the technician knows little or nothing about the "practical facts" surrounding specific problems, he will have more difficulty getting relevant information from the executive than if he has some clues as to what is significant. Similarly, if the executive is virtually illiterate with respect to mathematical matters, he will have trouble understanding what it is the technician is (or ought to be) after unless the latter is unusually skillful in explaining what it is he needs: For instance:

> Some executives would understand at once what was desired if the technician asked about the elasticity of demand for the product under consideration. The response would depend chiefly on the executive's familiarity with the terminology of economics. But a good many executives would not really understand the question if asked whether a given change in quantity produced a relatively greater change in price. The key word is "relatively," and it is quite commonly misunderstood by executives.
>
> This trivial point illustrates one kind of communication problem that exists—an unfamiliarity with the exact meaning of words in mathematics which are used loosely or carelessly in ordinary speech.

The executive must at least be able to understand what the technician wants and needs in order to mathematize a given problem satisfactorily or to recognize whether the problem is one that can actually be formulated mathematically. Mathematics cannot make something out of nothing; an incorrect formulation can be just as serious as inaccurate data—perhaps more so, for the possibility of errors in the data can often be provided for. For example:

> Suppose the mathematician is asked to tackle a problem of allocating overhead to various machine operations. To do this intelligently he may need to know such seemingly (to the executive) unrelated matters as the alternative uses of the various machines and the different market returns of the items produced.
>
> Further, he may want an idea of what degree of precision is needed in the answer for the purpose of making decisions; for if a range of error of plus or minus 10% is admissible, the procedure may be one fourth as cumbersome and expensive as if the error were to be held to 5%.

Similarly, to appreciate the limitations of answers supplied by his technicians, the executive usually cannot be completely devoid of mathematical knowledge.

In an effort to limit the number of variables considered in the mathematical formulation of problems, the technician tries to identify the more important factors in any given relation. One reason for this objective is evident to anybody familiar with the speed with which computational burdens pyramid as the variables increase in number; another reason is so that the results may be more meaningful. Executives are inclined to be impatient if the technician persistently wants to limit the number of variables

being actively considered. Their usual attitude is: "You've got to think about all the angles." To illustrate:

A textile manufacturer may wish to test a proposed new dish towel for market reaction by trial sales in a number of stores. Perhaps he would like to know about size, price, and color; and he has five possible alternatives for each of these factors. The possible combinations amount to 125. There would have to be a fantastic number of stores in the sample to get any significant results—and there probably wouldn't be that many stores available where conditions could be held comparable (as to time, size, type of customers, competition, and so on).

So the technician asks which factor or factors are important. In this case it might be that the size of the towel was limited by the width of the looms in the mill, and perhaps the sales records on previous towels already indicate the most popular colors, so the test can be narrowed primarily to the question of price.

But even here the technician can be helped to help the executive if the latter will accept findings which are, say, "70% probable." In other words, if the manufacturer has enough flexibility in changing prices subsequently so that he can take the 30% risk of being wrong in his initial price, then the number of stores that must be included will be fewer in number (so the research can be quicker and more economical), and they can be selected more precisely for comparability (so the results will also be more dependable *within the acceptable limitations of what is needed for making a practical business decision*).

Part of the explanation for executives' impatience is that they apparently have difficulty in distinguishing *degrees* of importance or feel that only *perfectly* precise statements are usable. When the technician attempts to pin down the executive as to how variables are related or how important they are, a very common—and quite unhelpful—reply is: "That's hard to say." If the businessman does not understand what is being asked (or is unable or unwilling to answer the question), the possibilities of mathematical treatment are noticeably limited.

FORMULATION

There probably is no limit to the amount of mathematics that could be used by business executives. However, to acquire such knowledge would entail costs—in terms of other branches of knowledge that could be acquired—which make the practical limit relatively low. Examples of applications of special branches of mathematics to business problems abound in the literature.[1] Fuller utilization of the mathematics already possessed by executives rather than expansion of mathematical knowledge might be a reasonable first step.

It should be re-emphasized that the executive is not expected to be active in the calculation and solution stage of problems being treated

[1] In addition to the HBR "Statistical Series" there are such publications as *Econometrica, Management Science,* and the *Journal of the Operations Research Society of America.*

mathematically. His work comes earlier—stating the problem with enough exactness so that it can be translated into mathematical language. Relevant factors must be identified and their relationship described; this will certainly require the executive's close attention. The executive is likely to be the only one able to state the proper "weights" or relationships to be employed in any mathematical statement of the problem. This is the key point in the process so far as the executive is concerned; it is here that he makes his unique contribution.

In making decisions in the traditional way—by entirely subjective methods—the executive somehow combines his evaluations of different factors in a manner that leads to a decision. He must decide how a given factor relates to the problem and what its magnitude will be, and must take into account any joint effects there may be. The influence of this particular factor is considered along with that of all the other factors the executive decides to take into account; the final decision rests on the composite effect of all factors.

The whole process being subjective, most of the variables are evidently not thought of in specific quantitative terms. The executive apparently thinks to himself, "That won't amount to much," or "This will be quite important," or some other evaluation of this general type. In a mathematical formulation the technician must elicit as much of this evaluation as possible from the executive in order to bring it to bear on the solution. While it is possible to do *something* even with loose statements of the kind quoted above, much more can be done with a more specific relationship even though it may be only approximate. Thus:

> It is better to say, "It typically costs $200 to get a customer back if we lose him" than to say, "It costs money to get customers back." It is better to say, "There are four chances out of five we'll lose a customer if we don't make immediate deliveries nine-tenths of the time," than to say, "Customers won't keep coming back forever unless we deliver promptly."

Ordinarily the mathematician cannot himself provide the relationships that are present; he must get these relationships described to him by management. He may, in some instances, be able to suggest mathematical procedures for evaluating data the company may have, and to help get certain relationships identified (such as those used in respect to customers in the last paragraph). But he can do practically nothing with respect to deciding what top management really feels the relative importance of various company objectives to be. To be included in mathematical models company objectives or policies must be stated in somewhat mathematical terms; and only the management can typically provide the information necessary to do this. For example:

> In a problem of setting up an inventory control system the executive must indicate what level of customer service he wishes to maintain and how much variation in employment he considers to be tolerable.

Thus his statement of the problem might be: "What will be the most economical production schedule that will provide us with sufficient stock so that we can fill customers' orders immediately nine times out of ten and not have more than a 25% variation in employment?"

A mathematical statement of the verbal explanation often facilitates the perception of implications of certain relationships, inconsistencies, and so on. Thus:

In the above example, attention might be called to the rate of fluctuation in customers' orders; and if it turned out that lumping of orders around the first of the month made a difference of 90% in the amount of safety stock needed, management might be prompted to take steps to reduce the monthly peak.

Unfortunately there is no reliable method of describing those classes of problems that are handled more efficiently with the aid of mathematical techniques. Where large numbers of variables are involved or chains of reasoning are long, a mathematical formulation is likely to be efficient if not indispensable, but even quite simple problems are sometimes best handled with mathematical tools.

EVALUATION

There are many examples in typical firms of failure to utilize even the most elementary mathematics in evaluating problems. Here are two glaring instances:

Comparing the cost of achieving an outcome and the value of that outcome should be a regular part of examining procedures and proposals, yet frequently is not. There is often inadequate consideration of what it costs to prevent a given kind of loss as compared with the size of the loss. If it costs $10,000 to provide a fire protection system which at most would prevent one $5,000 fire, the decision to install the system would be a poor one (if there were no secondary effects from the $5,000 fire, like disrupting the production line).

Accounting procedures are sometimes used which involve substantial outlays to develop data, or to provide accuracy in data, which simply cannot be justified in terms of the value of the results. A firm storing oil is reputed to have estimated its oil stocks by measuring the oil levels in tanks with a stick and then to have spent hundreds of clerk-hours in trying to reconcile to the pound its book inventory with that observed in the tanks.

Accounting data prepared for utilization in decision situations are often, at considerable extra expense, calculated to the penny when the decision requires data accurate only to the nearest thousand dollars. Large numbers of routine papers have been subjected to "clearance" by senior officers, at great expense over the years, largely because a junior official once made a mistake that cost the company, say, $1,400. No special training in mathematics is needed in order to make obviously reasonable assumptions and

to evaluate situations of this kind. Knowing and using arithmetic is adequate.

If any but the simplest relationships are present, or if the generality of a particular relationship is to be investigated, it is frequently valuable to utilize a more general language, namely, algebra. The use of this branch of mathematics greatly enlarges the scope of problems that can be efficiently treated. A further extension of the range of problems is achieved by using differential calculus. Here the obvious class of problems includes many having to do with maxima and minima, which were mentioned earlier. For example:

> Take a problem of determining the amount of dollars to spend for advertising *and* the quantity of product to manufacture. The relationship between the price at which the product can be sold, the quantity placed on the market, and the amount spent for advertising is assumed to be known, e.g., $P = f(x, a)$. Also known is the relationship between production cost and output, e.g., $C = \phi(x)$. To be decided are x, the amount to produce, and a, the amount to spend for advertising. By differential calculus, the values for x and a that will maximize profit can be obtained.

Indeed, for every kind of mathematics some business problem doubtless exists that can most easily be solved using the special features of the mathematics. And it is probably true that additional mathematical knowledge, of almost any kind, improves the mathematical "maturity" of the person. For most executives some knowledge of algebra, of the meaning of a functional relationship, and the rudiments of probability theory would constitute a fair beginning. For specific executive situations knowledge of special types of mathematics might be exceptionally valuable. But, in general, the higher his level, the less likely the executive is to require specific and technical knowledge of mathematics.

IV

SOME THEORETICAL ASPECTS OF CONTROL AND ADMINISTRATION

15. EVIDENCES FOR AN ADMINISTRATIVE SCIENCE

Kenneth E. Boulding*

Professor Kenneth E. Boulding examines the case for admitting the existence of an administrative science by noting the implications of the uses of the word "science" as part of the title of the new area. The article from which the following extract has been taken included a review of the first two volumes of the Administrative Science Quarterly *which has been omitted in the following material.*

One of the most striking intellectual movements of the past generation was the development of specialized fields of study and competence in the applied social sciences. Public administration, business administration, and social work had developed professional schools by the 1930s, to which now must be added new varieties such as hospital administration and hotel administration. Industrial relations emerged as an independent discipline

* From *Administrative Science Quarterly*, III (1958), 1-22. Reprinted by permission of the *Administrative Science Quarterly*.

somewhere around 1930-1940. International relations developed institutes of its own, and even economic development seems well on the way to being an independent field of study. These "applied fields" have usually grown out of social science "departments" and at first are usually attached to them. Thus business administration and industrial relations tend to grow up within economics, public administration and international relations within political science, social work and family relations within sociology, and so on. As soon as an applied field begins to separate itself from the parent "pure" discipline, however, it finds that it has to draw on *all* the social sciences for its theoretical substructures, its research methods, and its field of study. Thus industrial relations now has little more than a traditional attachment to economics; it draws its theoretical principles and its research methods from sociology, social psychology, and many other sources. The very process of developing an *applied* discipline compels the practitioner to search for his "pure" base in many different fields, both in theory and in research methods.

One of the applied social science fields which has developed with great fertility is that which deals with the structure, functions, and behavior of organizations. Administrative science would seem to be a perfectly good name for this field; parts of it, however, go under other names—management science, public administration, business administration, operations research, organization theory, to name merely the most obvious. Two newly established journals—*Management Science* and *Operations Research*—occupy at least part of the general field. The various journals put out by business schools cover a more specialized segment. One might even include the various activities which originate in and around schools of architecture under the general head of "planning." In addition to this outburst of fairly recent interest and activity there is an older movement, going back to Taylor and "scientific management" and to Gulick and Urwick and "public administration," which is so well established that by this time it is regarded as the "tradition" against which some of the newer movements are in revolt!

At the outset we might frown on two possible discussions of a purely semantic nature which would not be particularly fruitful; the first is the question of what is the "right" name for this general area of study, the answer to this question being that any name which is not misunderstood is "right." Operations research covers those parts of the decision-making process in organizations which are most susceptible to mathematical treatment, where the elements in the problem are well adapted to measurement, and where the problem of the criterion of success in the operation either presents no difficulties or can be solved for the purposes of the project in hand by some reasonable but arbitrary assumptions. Management science,

as reflected in the journal and the society of that name, has a rather broader frame of reference and is interested in more general problems and theories than the "pure" operations researchers. It still retains a strong focus of interest in mathematical models of behavior, in "systems research," and in the quantification of organizational processes. Administrative science, as reflected in the *Administrative Science Quarterly*, is oriented more toward sociology, social psychology, and the social sciences "proper." It is less mathematical in the technical sense and is more concerned with the broad application of the theories and methods of the social sciences to problems of organization. These three approaches are complementary rather than competitive; each occupies a different part of the broad field of organizational studies, with overlapping boundaries. There is not the slightest point in arguing which is the "right" or even the "best" approach.

The second useless controversy is whether any or all of these various studies deserve the holy name of "science." The question of whether a particular field of intellectual activity is "scientific" is seldom interesting. Knowledge is gained in all sorts of ways; methods which are appropriate in one area are not appropriate in others; and there is a large spectrum of more or less useful and knowledge-producing intellectual activities. It is unnecessary to label fields of study as more or less "scientific" and absurd to judge them by this label. Fields of study are more or less mathematical, more or less empirical, more or less experimental, more or less quantitative, more or less subjective, and so on, and in this many-dimensioned set each field must find that character which is most suited to its subject matter. The important question is not whether any field is "scientific" but whether its activities contribute usefully to the improvement of human knowledge and whether these activities might themselves be improved in various ways. If a purist for scientific method comes along to complain that administrative science is not "science," he can politely but firmly be shown the door, and we can get on with the business of examining whether the content of administrative science is appropriate to its field of study and whether its methods usefully advance knowledge in that field.

An economist can hardly fail to be impressed by the much higher level of generality in theoretical writing in the administrative science field by contrast with that in economics. The problem of the appropriate level of generality of theory is a difficult one; there is certainly need for work at many different levels. If a theory is to be fruitful in the sense that it points us toward conclusions which we would not have without it and toward empirical inquiry, which may either confirm it or force its reorganization, then it must find an "appropriate" level of generality. This must lie somewhere below that of the large philosophical generalization which points

to no conclusions and to no specific task of confirmation or refutation and somewhere above that of the *ad hoc* hypothesis which applies only to a particular case and has little or no significance outside a particular situation. If a theory is to be fruitful, it must also develop an appropriate level of abstraction for its concepts and constructs. Thus the development of a new abstract concept, like, for instance, the Shannon concept of information, often leads to a very fruitful development of theory. The trick here is to be able to select from the vast complexities of real phenomena just those abstract properties which constitute the essence of the situation for the purposes of study. There are no rules, unfortunately, by which appropriate levels of generality and abstractness can be discovered automatically; the appropriateness of a theory can be known only by its fruits.

The development of theory in administrative science is a formidable problem because of the inherent complexity of the field of study. Here we are dealing, not with simple mechanical systems, but with systems involving all the intricacies of human personality, images, and communications. Any theoretical systems that we can construct will fall far short of the inherent complexity of the reality. An organization includes within its framework *all* systems levels.[1] Purely mechanical systems, like the theory of the firm in economics, are by no means useless but will take us only a very small part of the way. If organization theory has gone beyond this level, it is because of the recognition of cybernetic or control systems as an essential part of organization and of information as an abstract quantity linking the "roles" which form the pattern of the organization chart, formal or informal.

Administrative science particularly needs good studies of exceptional individuals. Economics can get away with pretending that all men are much alike, for in the market place perhaps they are. As we move toward the study of organizations, and especially as we study the genesis and growth of organizations, the role of the exceptional individual, the role creator, the founder of religions, states, societies, and corporations, becomes more and more important. Biography is therefore an essential part of the raw material of administrative science. We still need to do much more thinking on how to integrate the knowledge gained from descriptive and historical case studies into the knowledge gained from empirical and quantitative research. This is, I suppose, one of the problems of theory—how to provide an abstract image which is constantly enriched by both forms and sources of information. It would be optimistic to suppose that this problem had been solved.

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[1] See K. E. Boulding, "General Systems Theory," *Management Science,* 2 (April 1956), 197, for a discussion of systems levels.

I turn now to the last category, that of empirical and quantitative research. If any single characteristic may be said to distinguish this form of activity from the preceding category of descriptive and historical work, it is the creation of "data." In descriptive writing the author takes a complex situation and tries to analyze it, as it were, in the raw. In "research" the investigator interposes a fairly standardized process of data collection between the situation and the analysis, and what he analyzes is not the situation but the data. The data may take the form of answers to questionnaires, or they may consist of formalized observations of behavior embodied in the investigator's notes. In either form it is usually capable of some forms of quantification and statistical analysis. The end product consists of *numbers* which summarize in some way the properties of the data (indexes, coefficients of regression or correlation, chi-squares, tests of significance, and so on) which are arrived at by standard processes which are presumably understood by both writer and reader. The numbers may also be arranged in tables, which likewise summarize, in more detailed fashion, certain broad properties of the data.

There are many advantages of this method. It is consistent with the methods of physical and biological science, which also abstract from the complexities of the "situation" a body of "data" which are then analyzed. When the situation is so complex as to defy analysis, it is a useful trick to substitute for it a body of data which *can* be analyzed. The principal danger of the method is that the investigator may be so absorbed in analyzing his data that he forgets entirely the situation out of which the data were abstracted. In the natural sciences this problem is not perhaps so serious as it is in the social sciences, for the world of nature is less complex than the investigator, and his abstractions, therefore, do less violence to the reality. In the social sciences, however, the investigator is dealing with situations of the same (or even of a higher) order of complexity than himself. In this case the problem of the critique (not merely of the analysis) of the data is of great importance. Social scientists are much too prone to concentrate on the problems of the analysis of their data rather than on the relation between the data and the situation. This is why I suspect that the good social scientist should always be paired with a humanist, at least inside his own head, who will constantly be looking at the situation as well as at the data and continually modifying the data-collection process in the light of increasing knowledge of the situation.

The intellectual disease of analyzing data to the *exclusion* of the situation may be called *data fixation.* Its principal symptom is a certain obsessiveness with arithmetic—the feeling that once a number has been arrived at by a recognized statistical ritual something has been accomplished. The article that is sandwiched between tables and peppered with coeffi-

cients of correlation and statistical tests of significance is highly suspect in this regard. There are too many spurious quantities in social science research. I must confess that I regard the invention of statistical pseudo-quantities like the coefficient of correlation as one of the minor intellectual disasters of our time; it has provided legions of students and investigators with opportunities to substitute arithmetic for thought on a grand scale. Arithmetic is so much easier than thought that the temptation to make the substitution is almost irresistible. When the arithmetic is performed by electronic calculators, the substitution is even more disastrous. I recall a remark of the great statistician and econometrician Henry Schultz that the great value of statistical computation (this was in the days of hand computers) was that it got the investigator thoroughly familiar with his data. Now, alas, only the I.B.M. machine gets thoroughly familiar with the data; the investigator does not. His data are served up to him in a variety of digested forms, and he surveys a product, which is as far removed from the data as the data from the situation.

It is the sense, I think, of a concerted effort by specialists from many different fields to solve a problem of great practical relevance to human welfare which creates the excitement—a sense also of new tools being applied to old problems and a certain air of hope and enthusiasm that a new step forward in man's understanding of himself and his society is being taken. Euphoria is, of course, no substitute for wisdom, the proof of the pudding is yet to come, and one wants to protect oneself against disappointment by suitable head shakings and a sound conservative melancholy; but for all this there is a feeling of dawn in the air, and it is good to be alive in it.

The importance of the problem can hardly be exaggerated: how can organizations be built, and by what principles shall they be conducted, which will serve to free and not to enslave the individual and which shall be protected against the gangrene of corruption which besets all human institutions? The question goes back at least to the Greeks, and all human history is man's failure to answer it. It is not too much to hope that the plodding bricklaying of the social sciences, working with the larger but more unstable self-knowledge of man that comes from the humanities, may in our day yield some better answers to this question than the past has ever afforded. This is a high purpose, and our age is somewhat ashamed and suspicious of high purposes, so let us not talk about it. But with a high purpose tucked somewhere into the background, a firm resolve to gather contributions from many different disciplines, a certain amount of methodological skepticism, and a desire to brew a tasty combination of humanistic and social-scientific approaches, I venture to predict for the *Administrative Science Quarterly* a long and useful life.

16. COMMENTS ON THE THEORY OF ORGANIZATIONS

Herbert A. Simon*

A leading authority discusses the major factors involved in developing a meaningful theory of organization.

THE SUBJECT OF ORGANIZATION THEORY

Human organizations are systems of interdependent activity, encompassing at least several primary groups and usually characterized, at the level of consciousness of participants, by a high degree of rational direction of behavior toward ends that are objects of common acknowledgment and expectation. Typical examples of organizations are business firms, governmental administrative agencies, and voluntary associations like political clubs.

In complex enterprises the definition of the unit is not unambiguous—a whole agency, a bureau, or even a section in a large department may be regarded as *an* organization. In such a nest of Chinese blocks the smallest multi-person units are the primary groups; the largest are institutions (e.g., "the economic system," "the state") and whole societies. We will restrict the term "organization" to systems that are larger than primary groups, smaller than institutions. Clearly, the lower boundary is sharper than the upper.

Complexity in any body of phenomena has generally led to the construction of specialized theories, each dealing with the phenomena at a particular "level." Levels are defined by specifying certain units as the objects of study and by stating the propositions of theory in terms of intra-unit behavior and inter-unit behavior. (Cf. the sequence of elementary particle-atom-molecule in physics and the sequence: gene-chromosome-nucleus-cell-tissue-organ-organism in biology.)

Not every arbitrarily selected unit defines a suitable level for scientific study. The most important "unities" that make a level an appropriate one for theory construction and testing appear to be the following:

(a) The units at the level in question should exhibit a high degree of internal cohesion relative to their dependence on each other. Under these circumstances we can discover generalizations about the internal properties of the individual units as quasi-isolated systems (e.g., propositions about communications patterns among component primary groups of an

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* From *The American Political Science Review*, XLVI, 4 (1952), 1130-40. Reprinted by permission of the American Political Science Association.

organization). We can also discover approximate generalizations about the relations between units as wholes (e.g., propositions about competition between two organizations).

(b) The units should exhibit internal properties that are different (or depend on different mechanisms) from those that predominate in the internal properties of sub-units at the next level below (e.g., the determinants of the volume of communication between members of two different primary groups in an organization should be distinguishable in important respects from the determinants of the volume of communication between members of a single primary group).

These two tests are not intended as metaphysical assertions about "wholeness" or "emergent" properties, but simply as criteria determining whether, in fact, verifiable propositions can be constructed employing the units in question as approximations to the full complexity of nature. Even if at some stage in inquiry we should be able to reduce the propositions of theory at one level to those at the next lower level—as the theory of gases has been reduced to statistical mechanics—the former propositions would still retain their usefulness for purposes of application and economy of statement. Indeed, the value of both sets of propositions is enhanced by their translatability from the one to the other.

Human organizations would seem to qualify to a high degree as suitable units defining a level of analysis of systems of human behavior. With respect to the first criterion stated above, the most superficial observation shows that the boundaries between organizations have real behaviorial significance, and that it is meaningful, in first approximation, to state propositions about the relations between organizations regarded as wholes. (I trust that I have made clear that no notion of "group mind" is implied in this last statement.)

With respect to the second criterion, I believe that enough is known about the psychological mechanisms that are primarily responsible for cohesion and interdependence in the primary group to show that these mechanisms cannot easily account for the corresponding phenomena in the larger organized aggregates; and that there are important organizational phenomena that do not have exact counterparts at the primary group level. A number of examples of these mechanisms and phenomena, which are central to organizations but absent from or of lesser importance to primary groups, will be given in the next section.

But why speak of *a* level of organization theory? Do we not need as many levels as there are structural layers between primary groups and institutions? I think not, because I do not believe that these various levels are distinguishable to an important extent in terms of the second criterion suggested above—i.e., there are no important new mechanisms to be discovered at these successive levels. The propositions of organization theory

can probably be stated with systematic ambiguity so as to refer indifferently to the relations of divisions within a bureau or the relations of bureaus within a department. As small differences in degree begin to approach qualitative significance at the upper end of the scale, we have probably already reached the level of institutional theory. In the future, of course, the results of research may force us to revise this assumption and to introduce additional levels of theory.

MAJOR PROBLEM AREAS

The study of organizations has hardly progressed to the point where a definitive list can be constructed of the major areas for research. The following list was arrived at primarily by considering which characteristics of organization—particularly those distinctive ones that identify the level of organization theory—require dissection and explanation. I have not tried to construct watertight categories, and it will become evident that several of the items represent different ways of looking at the same problem. Until we know what frames of reference are going to be the most useful for organization theory, it will surely be desirable to retain alternative frameworks, and to take considerable pains to develop means for translating from one framework to another.

1. The process of decision-making in organization. A language for the description of decision-making processes appears to offer considerable promise as a framework for the study of organizations. The central notion is that a decision can be regarded as a conclusion drawn (though not in any strict logical sense) from premises; and that influence is exercised by transmitting decisions, which are then taken as premises for subsequent decisions.

When the problem of influence is stated in these terms, our attention is called to some features that are not prominent in other formulations. We see, for example, that the process may depend not only upon interpersonal relations between influencer and influencee, but also upon the structure and accepted rules of transformation of the language employed by them. One can begin investigation here by posing such questions as how influence is transmitted in an organization between professional groups that employ different problem-solving technologies, e.g., accountants and engineers. Work on organization theory utilizing this framework could probably soon be related, in a mutually beneficial way, to research on the sociology of knowledge and on the psychology of the problem-solving process.

2. The phenomena of power in organizations. A characteristic feature of the mutual influence of organization members upon one another is that this influence exhibits striking asymmetries—as, for example, in the

superior-subordinate relationship. These asymmetries appear to be what we have chiefly in mind in using such terms as "power" and "authority." The following are a number of important research tasks in this area.

a. A fully operational definition of power and methods for observing and measuring power relationships is not yet at hand, but would seem fundamental to the description of organizational behavior.

b. More needs to be learned about the motivational basis of power in organizations, including the roles of sanctions, identifications, and attitudes of legitimacy in the acceptance of authority. Progress has been made in the study of the analogous phenomena in primary groups (e.g., work on leadership and on group morale), but it is not obvious that the mechanics of influence within the primary group tell all, or even most, of the story of influence processes in larger organized aggregates.

c. In elaboration of the last point, the distinction between the "formal" and the "informal" in organizations appears to lie, in part, in differences between the psychological bases of cohesion that are involved. When we refer to power as formal, what we appear to mean is that internalized attitudes toward legitimate authority provide the motivation for acceptance of the relationship. While feelings about legitimacy undoubtedly play a role in primary group relationships, I would conjecture that they take on additional importance when they serve as a substitute for the immediate experience of approval and disapproval in face-to-face relationships.

d. Another mechanism that is important in the transmission of influence in organizations is the interlocking of primary groups through the dual membership of supervisory employees. In general, each supervisory employee is a member both of a group in which he is formal leader and of another in which his immediate superior is formal leader. The principal research problems here are to determine the behavior patterns that are adopted by executives in these "cross-pressure" situations; and, if there are several such patterns, to find what determines which one will be adopted. The same questions need to be answered with respect to the "staff" man who, because he is attached to a "line" unit, also has potential or actual membership in two primary groups. It remains to be seen whether cross-pressures produce the same behavior in these organizational situations as in the other social situations where they have been studied.

3. Rational and non-rational aspects of behavior in organization. Organizations are the least "natural," most rationally contrived units of human association. But paradoxically, the theory of an organization whose members are "perfectly rational" human beings (capable of unlimited adaptation) is very nearly a perfectly vacuous theory. It is only because individual human beings are limited in knowledge, foresight, skill, and time that organizations are useful instruments for the achievement of

human purpose; and only because organized groups of human beings are limited in ability to agree on goals, to communicate, and to cooperate that organizing becomes for them a "problem."

Organization theory is centrally concerned with identifying and studying those limits to the achievement of goals that are, in fact, limits on the flexibility and adaptability of the goal-striving individuals and groups of individuals themselves. The entrepreneur of economic theory is limited only by constraints that are external to himself and his organization—the technology—and by the goal-striving of individuals whose interests are not identical with his. Administrative man is limited also by constraints that are part of his own psychological makeup—limited by the number of persons with whom he can communicate, the amount of information he can acquire and retain, and so forth. The fact that these limits are not physiological and fixed, but are instead largely determined by social and even organizational forces, creates problems of theory construction of great subtlety; and the fact that the possibilities of modifying and relaxing these limits may themselves become objects of rational calculation compounds the difficulties.

In this general area of research, promising suggestions as to the direction in which we might move are contained in oligopoly theory and game theory (formulation of the "outwitting" problem), and in sociological speculations about the self-confirming prophecy. I would single out the following areas for special attention:

a. Identification of the limits of rationality. We need a more complete and systematic taxonomy of the constraints, internal to the system of social action, that serve as limits to the attainment of goals. This would lead to empirical research on the questions: (i) under what circumstances particular constraints do and do not operate, including inter-cultural uniformities and differences, and (ii) under what circumstances the modification of removal of particular constraints becomes an object of rational calculation.

b. Theory of organizational innovation and change. Plans are regarded as "utopian" when their implementation would require changes in internal constraints that are thought to be unchangeable. Essentially, utopian plans are rejected because "you can't change human nature" in those respects that would be essential to achievement of the plan. Research is needed as to the criteria that are applied by human beings in planning situations to determine which of the behavior variates they will regard as variable (i.e., subject to rational determination), and which as fixed (i.e., constraints on goal attainment).

c. Reification of groups. The limit of human understanding in the presence of complex social structures leads human beings to construct simplified maps (i.e., theories or models) of the social system in which they are acting, and to behave as though the maps were the reality. To the extent

that such maps are held in common, they must be counted among the internal constraints on rational adaptation. What we have just said applies, of course, to all systems of classification which, by determining when situations are "similar" and when "different," provide the individual with the social definition of the situation.

My earlier comments about the relation of "formal" organization to attitudes of legitimacy can be generalized in terms of this notion of social classification. The process of organizing involves, among other things, securing acceptance by the organization members of a common model that defines the situation for them, and provides them with roles and expectations of the roles of others, and with commonly accepted classificatory schemes. Attitudes of legitimacy probably provide a principal motivational base for the organizing process.

What is needed here is study of the factors that determine how an organization will be perceived by the persons in it, how the mode of perception affects behavior, and what the effects are of a greater or lesser degree of sharing of such perceptions.

4. The organizational environment and the social environment. Members of an organization generally come to it already equipped with the mores of the society in which it operates. To what extent can and do organizations develop and inculcate mores that are distinct from the mores of the society? To what extent are there in a society *generalized* mores about behavior in organizations that provide the basis for the operation of the individual organizations in the society (e.g., generalized mores about superior-subordinate roles)?

Organization theory has been largely culture-bound through failure to attack this problem. The theory of bureaucracy as developed by Max Weber and his followers represents the furthest progress in dealing with it. The historical data appealed to by the Weberians need supplementation by analysis of contemporary societies, advanced and primitive. A comparison of intracultural uniformity and variation in organization patterns with inter-cultural uniformity and variation would provide the evidence we need to determine to what extent the cooperative patterns in organizations are independent of the mores of cooperation of the society.

5. Stability and change in organizations. Any theory of the movement of a system of organizational behavior through time must take account of the apparent stability exhibited by organizations. From every evidence, this stability must be an extremely complex phenomenon. It may rest in part on the kinds of bonds, which we might refer to as non-rational, that have been observed in the primary group; it may depend in part on the rational calculations of members that their interests are served by the organization. It is because the role of these, and possibly other, bases of stability needs to be explored that I offer the following suggestions:

a. It is possible that systems in which the "non-rational" type of stabilizing mechanism predominates will behave in a qualitatively different fashion from those in which the "rational" type of stabilizing mechanism prevails. If, by construction of models embodying the two types of mechanisms, a qualitative difference could be deduced, the way would be open to empirical assessment of the importance of the two mechanisms.

b. The work that has been done to date on the theory of the "rational" mechanism would suggest that stability in this case depends on certain relations between the aspiration levels of members and their achievement levels. If so, we can draw on the psychological research that has already been done on these latter phenomena to design experiments and field studies that would test whether this is, indeed, one of the mechanisms involved in stability.

c. We may borrow the economists' term "entrepreneur" to refer to an individual who specializes as a broker in finding mutually acceptable terms on which a group of persons can be induced to associate, or to continue association, in an organization. We need research to determine what the role is of entrepreneurship, so defined, in the process of organizational activity. I conjecture that there are some close relationships both with the "middleman" notion, introduced in topic 2 d, and with the kind of stability mechanisms discussed in 6 b. Study is also needed of whether the uniqueness or non-uniqueness of the acceptable terms of association is an important determinant of the amount of authority that can be exercised over organization members. This relationship has been exhibited in some formal models, but it needs empirical verification.

d. The two topics just discussed get very close to the heart of the processes of bargaining and the formation of coalitions, insofar as these processes involve rational calculation of advantage. The formal apparatus of game theory appears to provide an appropriate language of theory formulation, and, on the empirical side, some of the problems could probably be examined by means of relatively small-scale laboratory experiments.

e. Another aspect of survival and stability is the question of how organizations adapt themselves to uncertainty and incomplete information. In the past two decades this has been a favorite topic of economists, but only in the last five years has there been much attention to the two aspects of greatest importance to organization theory: (i) reduction in the impact of uncertain events by retention of "flexibility" and (ii) the role of a stable social environment as a means of providing predictability to the individuals who are a part of it.

Under the first heading, research is needed as to the implications of particular ways of organizing behavior for the adaptability of the organization under changing, unpredictable circumstances. Under the second

heading, research is needed as to the existence and nature of mechanisms in social organizations that are analogous (in the sense of performing the same function) to the homeostatic mechanisms of organisms. Whether organizations are adaptive and possessed of homeostatic mechanisms is an empirical question, but one which, in all probability, can be answered in the affirmative. But the important theoretical issue is the nature of the mechanisms—a question that is not solved by reference to the organistic analogy. Moreover, while primary groups and social institutions may also exhibit homeostasis and adaptivity, there is no reason to believe that the mechanisms involved are the same ones that produce these phenomena in organizations. Functional equivalence does not imply structural equivalence.

6. Specialization and the division of work. The division of work and the design of the organizational communications system have in the past been the central concerns of persons interested in organization theory for purposes of application. The question usually asked is: "How do we divide the work, and what channels of communication do we establish in order to operate efficiently?" For purposes of research, the question is more properly stated: "What are the consequences for organizational activity of dividing the work one way rather than another, or employing one set of communications channels rather than another?"

The last half of the question (communications) is best answered in terms of the frames of reference of topics 1 and 2. The subject of the division of work requires further comment. We are considering, of course, not only the question of specialization of the individual organization member, but also the allocation of tasks to whole organization units—in fact, it is the question of specialization among the larger aggregates rather than specialization within the primary group that is the proper concern of organization theory. We are equally concerned with "vertical" specialization—i.e., allocation of decision-making functions to various status and authority levels in an organization—and with "horizontal" specialization—i.e., fixing the jurisdictional boundaries of co-ordinate organizational units.

a. Current theories of specialization in organization (excluding the "human relations" approach to the primary group) are largely derived, via the scientific management movement, from Adam Smithian notions that specialization is a means to efficiency and hence to effective competition. There has been little examination of the alternative Durkheimian idea that specialization is a means of *protection* from competition. The research problem suggested by the contrast is to examine in what respects specialization (and what kinds of specialization) increases organizational stability; in what respects it jeopardizes stability; and to what extent these considerations enter into decisions about specialization. The problem

is also related to 5 e in that certain forms of specialization may make an organization less dependent on what other organizations do, and hence may provide a means for dealing with uncertainty.

b. The consequences of specialization depend on the constraints discussed in topic 3. It is an important question as to how far specialization is determined by constraints external to the organization—the technology of its activities—and how far it is determined by internal constraints—the psychological and sociological limitations upon rational adaptation. (The situation is even a bit more complicated because the technology—in the sense of the physical, chemical, biological, etc., processes involved in the organization's activity—is not independent of the state of technological knowledge, and the latter may, in turn, be interdependently related to the forms of social specialization that prevail.) In almost every city, the fire department is a recognized organization unit, and in almost every steel mill, the blast furnace department. Here are examples of specialization that appear to be dictated by the technology—the units are "natural" in this sense. On the other side we find units that are "natural" in the sense of being specialized to handle socially-defined purposes, which, in turn, depend on the processes of reification discussed in 3 c (e.g., the Children's Bureau). Research into the theory of specialization making use of the framework suggested in topic 3 is needed to clarify these issues, and to formulate and test propositions about the consequences of specialization.

c. The relationship between specialization and the internal constraints on rational adaptation is two-way. The division of work may be determined, partly or wholly, by such constraints; it will in turn create constraints. That is, the form of specialization will be a major determinant of the frames of reference, skills and knowledge, identifications and foci of attention of organization members. Probably this is the most promising viewpoint from which to tackle the non-rational aspects of formation of group identifications (or "interests" in the political sense) and the effects of such identifications upon inter-group processes (cf. 5 d on the "rational" aspects).

d. Problems of vertical specialization are closely related to topics 1 and 2. In applied organization theory, the questions are usually stated in terms of "centralization" and "decentralization."

This list of research areas illustrates, I think, that the phenomena of organization constitute an important level of theory—a level that is encompassed neither by the usual conceptualizations of small-group processes nor by those of the more macroscopic analyses of cultures and institutions.

The characteristics of this level that give it its particular "flavor" are the following: (a) its focus is on relations among interlocking or non-interlocking primary groups rather than on relations within primary

groups; (b) it is largely concerned with situations where *zweckrationalität* plays a large role relative to *wertrationalität* (as compared with the study either of small groups or of cultures); (c) in these situations the scheme of social interaction becomes itself partly a resultant of the rational contriving of means and the conscious construction and acting out of "artificial" roles; and (d) explanation of phenomena at this level requires the closest attention to the fluid boundaries of rational adaptation, including the important boundaries imposed by group frames of reference, perceptual frameworks, and symbolic techniques. In contrast to these characteristics, the level of primary group theory must pay much more attention to the personal values that are emergent from the process of group interaction itself, the acculturalization of individuals to the group, and the particular forms of cohesion that arise out of face-to-face interaction and individual sensitivity to group approval.

It would be wrong, of course, to insist that none of the primary group phenomena are relevant to inter-group relations, or vice versa. Nevertheless, the important work that has been done on small groups in the past generation—much of it involving the observation of groups that were part of larger organizational structures—has contributed very modestly to the solution of the problems of organization theory.

17. TOWARD A THEORY OF ORGANIZATIONAL BEHAVIOR

Robert V. Presthus*

Professor Robert V. Presthus explores theoretical formulations from sociology and psychology in an attempt to set down a general theory of organizational behavior. The article is of particular interest because of its insight into the factors entering into the structuring and functioning of an organization such as a large business unit.

During the recent past the analysis of organization has shifted from a preoccupation with structured rationality to an emphasis upon individual behavior. Much of this emphasis has been sociological, that is, it is concerned mainly with small groups and with the ways in which such groups shape the alignment and use of power in the organization. The following

* From *Administrative Science Quarterly*, III (1958), 48-72. Reprinted by permission of the *Administrative Science Quarterly*.

analysis attempts to add another dimension to this main drift by pulling together the insights of several social sciences into a general theory of organizational behavior. Such efforts seem required, however crude and abstract they may be at this early stage in the development of administrative science.

In line with Merton's plea for more attention to the interplay between bureaucratic structure and personality,[1] some psychological formulations are brought to bear upon two major variables, the total organizational situation and the individual. Such a framework seems well suited to the complexity of organizational behavior, which is the product of interaction among the whole culture, a given organization, and an individual personality which itself is the result of the genetic composition and unique experience of any given individual. In this context an organization may be viewed as a miniature society in which traditional social controls over the individual appear in sharp focus. The organization draws upon the accumulated learning and experience of the individual, who brings to it certain socially inculcated attitudes that encourage a satisfactory accommodation to the organization's major values and expectations. Obviously not all individuals achieve this kind of accommodation, but the vast majority do so at varying levels of identification and self-realization.

Without denying the influence of informal, small-group liaisons, we assume that individuals have several reference points other than their immediate work group, including the organization as a whole. This concept of differentiated reference foci is suggested by the dichotomy between "cosmopolitans" and "locals," between those whose loyalty is bound up with their own organization (locals) and those whose referential context is profession-wide and national (cosmopolitans).[2] Here we are concerned mainly with "locals" who tend to accommodate successfully. While our theory necessarily includes an "ambivalent" type who tends to reconcile inapposite adjustment by resignation, aggression, and withdrawal, this inquiry is directed toward those "upward-mobiles" and "indifferents" to whom the organizational bargain is either satisfactory or at least insufficiently unsatisfactory to provoke disengagement. The question thus becomes, What aspects of the dynamic interplay between the total organizational situation and the individual encourage these different kinds of accommodation? Part of the answer seems to lie in the individual's perception of the organization as a social instrument and in the ways that the organization engages the deep-seated attitudes of the individual toward authority.

[1] Robert K. Merton, "Bureaucratic Structure and Personality," *Social Forces*, 17 (1940), 560-68.

[2] Cf. Alvin W. Gouldner, "Cosmopolitans and Locals: Toward an Analysis of Latent Social Roles," *Administrative Science Quarterly*, 2 (Dec. 1957-March 1958), 281-306, 440-80.

In this general framework, organization is defined as a system of structured interpersonal relations, that is, individuals are differentiated in terms of authority, status, and role with the result that personal interaction is prescribed or "structured." Anticipated reactions tend to occur, while ambiguity and spontaneity are decreased. It is hypothesized that the resultant psychological field has exceptional influence upon learning and accommodation to the organization.[3] A related hypothesis is that behavior will tend to be more predictable in complex, structured organizations than in so-called voluntary associations. These assumptions reflect Harry Stack Sullivan's interpersonal theory of psychiatry and particularly his view that "the human organism is so extraordinarily adaptive that not only could the most fantastic social rules and regulations be lived up to, if they were properly inculcated in the young, but they would seem very natural and proper ways of life."[4] It would seem that the rational character and demands of the typical big organization will surely appear less than "fantastic" to its members.

According to Sullivan, personality is the result of a "self-system" worked out through successful (anxiety-reducing) accommodations to the wishes of successive authority figures, such as parents, teachers, supervisors, and so on. The theory of anxiety is central, since anxiety is the principal medium by which the individual is exposed to the values of those in authority. Sullivan's conclusions as to the significance of the anxiety-conformity-approval syndrome can be summed up as follows: "I believe it fairly safe to say that anybody and everybody devotes much of his lifetime and a great deal of his energy . . . to avoiding more anxiety than he already has, and if possible, to getting rid of some of this anxiety."[5]

It is assumed here that anxiety is probably the most critical variable in organizational behavior, when such behavior is defined as an interpersonal process occurring in a highly structured environment. Such behavior is always associated with individual reactions to authority, which in turn are mediated by anxiety and the structure of the immediate interpersonal situation. It is important to add that anxiety occurs along a continuum,

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[3] By "organization" I mean the ideal-typical bureaucratic model, characterized by large size, hierarchy, specialization, centralized formal power, and an orientation toward written rules and tradition as the main guides to behavior. Examples include a government bureau, a large university, an industrial concern with something over one thousand employees, an army command at the regimental level or above. Members of these organizations are usually selected on the basis of technical skill; typically, they view their vocation as a career, with clearly defined avenues. This model is highly idealized, of course, but perhaps no more so than the economist's "law" of supply and demand, which has proved quite useful for analytical purposes.

[4] H. S. Sullivan, *The Interpersonal Theory of Psychiatry* (New York, 1953), p. 6.

[5] H. S. Sullivan, "Tensions, Interpersonal and International," in H. Cantril, ed., *Tensions That Cause Wars* (Urbana, Ill., 1950), p. 95.

ranging from extreme, disorganizing fear to the natural uneasiness felt by most people in a strange situation. For our purposes, anxiety is defined as an unpleasant tension that, in Sullivan's terms, guides the development of the self-system, is present in some measure in all interpersonal relations, and is the main influence determining how such relations develop. This degree of tension may be called "adaptive anxiety" because in most cases it facilitates personal accommodation. In terms of organizational needs, such anxiety and the "security operations" that seek to overcome it are usually functional.

This is not to say that anxiety reduction is the *only* motive for accommodation. Individuals seek opportunities for joy, love, self-realization, and power, which are not necessarily tied to anxiety, although they may be. Certainly, because power in our society can usually be equated with the control of organized resources, organizations provide unusual opportunities to satisfy this drive. But for the majority such expansive states as deep emotional satisfaction, love, and self-realization are not usually obtainable within the organization, which instead tends to stifle the spontaneous, idiosyncratic satisfactions that individuals seek. The "professional mask," the pleasant detachment, the rivalry, and the anxiety that characterize interpersonal relations in big organizations are germane. For most of us, impersonality, limited discretion, built-in power inequities, and the fact that work often becomes a means of buying more meaningful off-the-job satisfactions suggest that less positive motives such as anxiety reduction warrant closer analysis.

Something may now be said about the relation of anxiety to learning. Anxiety is apparently a kind of free-floating dread that affects most interpersonal relations to some degree. Unlike fear which has objective referents, anxiety is often vague. Moreover, whereas fear usually relates to physical injury, anxiety relates to threats against personal esteem. But anxiety also has a positive role: it facilitates learning by sharpening both motivation and perception. As Sullivan concludes, "The first of all learning is called out to avoid recurrence of the extremely unpleasant tension of anxiety, which is, and always continues to be, the very antithesis of everything good and desirable . . . the child soon learns to discriminate *increasing* from *decreasing* anxiety and to alter activity in the direction of the latter. The child learns to chart a course by the anxiety gradient."[6]

Broadly, then, this analysis is grounded in the environmental school of psychology, which, without denying the biological foundation of human behavior, believes that cultural values play a major role in determining man's character. While this school is a minority one in psychology, its

[6] *Ibid.;* also see John Dollard and N. E. Miller, *Personality and Psychotherapy* (New York, 1950), p. 190; O. H. Mowrer, "Anxiety Reduction and Learning," *Journal of Experimental Psychology*, 27 (1940), 497-516.

formulations seem to me to be most useful in analyzing organizational behavior. Believing that social institutions shape behavior, this school turns to anthropology and sociology as well as biology to understand man. The theory and research of cultural anthropology reinforce the view that environmental conditions largely shape individual behavior and personality, since biological impulses such as pugnacity and competitiveness take quite different forms in different societies. The attending emphasis upon anxiety follows, since it becomes the primary mechanism for exposing the individual to cultural pressures. In the context of organization, it is significant that both Fromm and Thompson agree that the so-called "marketing character," who can be equated with the successful "other-directed" organization man, will "often tend to automaton conformity."[7] Finally, since individual reactions to organizational stimuli are the result of learning, the concepts of perception and reinforcement are enlisted to help explain behavior in a structured environment.

These several formulations underlie the present assumption that the patent status and power apparatus of organizations sharpens anxiety and thus increases the probability that behavior will reflect organizational premises. Complex organizations have an exceptional influence upon individual behavior because they are organized systems of expectation. Their status and authority symbols function as patterns of manifest stimuli that reinforce the human tendency to honor majority values. The probability of compliance is increased by the fact that organizational behavior is group behavior of an exceptionally structured kind.

All human behavior occurs within some normative framework, consciously articulated or (more frequently) tacitly assumed. In big organizations there is a fairly consistent hierarchy of values, culminating in a final ideal, the "good of the organization." Among the advantages of such a criterion is its flexibility and ambiguity—it can be manipulated to meet most exigencies. Because the organization must always compete for popular approval, consumer loyalty, and legislative protection and because its power must be constantly nourished, its major values become important tactical instruments. They are personified by the leaders of the organization and explicit in its traditions, and they provide behavioral cues for its rank and file. The assumed best interest of the organization thus provides a standard for determining policy, evaluating individual performance, defining loyalty, and rationalizing injustice if injustice becomes necessary. Obviously this standard may be misapplied in any given instance, but this

[7] C. Thompson, *Psychoanalysis: Evolution and Development* (New York, 1950), p. 208; also, for an excellent, methodologically rigorous work which interprets behavior in anxiety-reduction terms, see Timothy Leary, *Interpersonal Diagnosis of Personality: A Functional Theory and Methodology for Personality Evaluation* (New York, 1957).

possibility is not significant here because the decision makers always try to apply it rationally.

Imperatives such as these are reflected in the psychology of the organization. They result in a conscious effort to increase its predictability and internal discipline. The organization tends to become a routine of skill, energy, and opinion. The structured interpersonal relations with which this analysis is concerned are part of this rational climate. They increase the probability that individual behavior will reflect organizational necessity. The individual is conditioned to accept the legitimacy of obedience, for example, by the very fact that he has been hired to do a specific job with explicit obligation, by the provision of rules and regulations that limit his discretion, and by the definition of his place in a hierarchy of authoritative relationships. But such situational factors become most meaningful in terms of the psychological impact they have upon members of the organization. The resultant attitudes, it must be said, obviously help the organization achieve its objectives, but they also have certain unanticipated consequences that are dysfunctional in terms of such goals and of personal adjustment.[8]

We turn first to learning theory, because individual accommodation to the organization is essentially a matter of learning. Learning may be defined as a modification of behavior resulting from repeated exposures to a certain kind of stimuli. Learning proceeds according to a stimulus-response mechanism; its effectiveness depends upon various factors, including the number and strength of existing habits, perception, and the strength of the drive evoked by the stimulus. Perception is the process of becoming acquainted with the environment. Its motives include anxiety and what seems to be an instinctive tendency to use our sense organs functionally.[9] Random observation suggests that we appraise new social situations in order to orient ourselves, to decide what role is required. Our perception of a situation defines our behavioral limits in the sense that its speed and accuracy determine the appropriateness of the role we choose.

Obviously differences in intelligence, emotional maturity, and motivation influence perception and behavior. Some individuals have a limited social sensitivity, that is, their reactions are inappropriate to the "normal" expectations of a given situation. Such behaviors reflect, in part, inadequate or distorted perception. Among higher animals, whose perceptual organization is acquired (learned), the sensitivity toward, range of, and discrimination among stimuli are greater than in lower animals, who depend largely upon inherent perceptual facility. Man is highly susceptible to learning because he is more aware of stimuli and more selective than

[8] Merton, *op. cit.;* C. Argyris, "The Individual and Organization: Some Problems of Mutual Adjustment," *Administrative Science Quarterly*, 2 (June 1957), 1-24.

[9] S. S. Stevens, *Handbook of Experimental Psychology* (New York, 1951), pp. 357-58.

other animals. It is also clear that perception is bound up with environment, since the latter provides the potential stimulus field. This leads to a basic assumption: *In the structured milieu of a big organization, we can assume that both perception and conditioning are facilitated by the manifest, authoritative nature of the stimuli.*

Reinforcement is also vital to learning, since it makes possible conditioning through rewards and punishments. We know that responses which are followed by reinforcement will be learned; they will result in changes in the individual's behavior or response patterns. Individuals develop certain tensions reflecting needs for food, water, sex, recognition, power, security, and so on. The behaviors which satisfy these needs are reinforced because they reduce the tension generated by the need. The reduction of tension is thus an unusually powerful reinforcement. Learning is also mediated by attitudes, that is, dispositions to act in a certain way. We learn things that agree with our preconceptions much easier and retain them longer than those that seem alien. Through this process of selective perception a steady reinforcement of accepted values occurs. The reinforcement that accompanies the reduction of other tensions also operates with regard to the anxiety reduction achieved by deference to authority.

While there is disagreement as to the applicability of their findings to human conduct, Pavlov and Skinner have shown how problem-solving in dogs and rats can be conditioned through the manipulation of stimuli and the use of rewards and punishments.[10] Pavlov's experiments demonstrated the conditioned response by adding a new stimulus, a bell sound, to the environment of dogs in a feeding situation. Normally, dogs salivate only when being fed or upon seeing food, but after the bell was rung many times just before the dogs were fed, Pavlov found that the sound itself caused salivation. The animal had become conditioned to the bell sound. Skinner's experiments with rats illustrate the importance of reinforcement in learning, using the reward principle. A hungry rat, placed in an empty box equipped with only a lever which releases food to him, will in time depress the lever. The consequent reduction of hunger increases the chances that the rat will repeat the action. This is a nice example of the need-reduction principle in behavior or learning.

Reinforcement and motivation, building upon individual needs and the perceived means to meet them, lead to learning and habit formation. Through learning, the individual gradually selects from among several potential behaviors those which seem to have the best consequences in a given situation. The rationality of his choices will vary according to his intelligence, knowledge, information in a given situation, social perceptivity, and so on. *In a bureaucratic setting, the predictability of behavior and the probability that it will be functional in organizational terms are*

[10] I. P. Pavlov, *Conditioned Reflexes* (Cambridge, Eng., 1927); B. F. Skinner, *The Behavior of Organisms* (New York, 1938).

greatly enhanced by the limited number of behavioral alternatives. Functional responses are reinforced by rewards. In bureaucratic occupations an obvious example is the granting of frequent yet small pay increases. We can assume that the stimuli which elicit desired reactions are manipulated in terms of organization needs. Such manipulation occurs at various levels of sophistication, but the harnessing of social science research to commercial objectives, advertising and sales psychology (e.g., the impact of repetition), opinion surveys, consumer research, the professionalization of charity fund drives, and so forth suggests the growth in the systematic molding of human behavior.

Something must now be said about authority, which is among the main conditions of organized behavior. Authority is usually defined as the ability to elicit compliance whether or not the employee believes an order ought to be obeyed. In the sense that the leader must be able to secure consent from his followers, it is clear that authority, like power, is reciprocal. This definition of authority is acceptable if we remember that the symbol "consent" has more than merely permissive connotations and that consent is only the final, manifest expression of many complex motivations, mediated by the current interpersonal situation and the personalities of those concerned. We must ask *why* the individual accepts authority.

To say that authority is defined by consent suggests that the subordinate has a real choice between acceptance and refusal, that his response to an authoritative order is an "either-or" proposition. But this view not only neglects the disparities in power and security between the organization and the individual and between different individuals in the same organization; it also posits too great a degree of free will and too simple a social situation. Here again psychology and anthropology are helpful. As we have seen, from infancy on the individual is trained to defer to authority. He develops over time a generalized deference to the authority of parenthood, experience, knowledge, power, and status. Moreover, in any given dependency situation, many factors operate to negate the "either-or" notion. There are so many degrees of compliance, ranging all the way from enthusiasm to resignation, that outright rejection of an order becomes a gross and unlikely alternative, particularly among highly socialized (aggression-repressing) members of the organization. (We assume that most middle- and upper-level members will tend to be highly socialized owing to the technical demands of organization and the extended education required to gain the necessary skills.) We assume that consent will be normal. In a structured situation, when consent is withheld it is expressed in socially acceptable terms: orders are evaded, misunderstood, forgotten, or projected upon someone "better qualified," and so on. In any event, so long as subordinates know that a superior controls ultimate sanctions to compel obedience if his orders are resisted, how can authority validly be defined as a matter of consent?

When authority and the symbols that define it are organized and patent and there are known sanctions to encourage desired reactions, we seem to have left the permissive level of influence for the authoritative level of power. In terms of a continuum of sanctions, we can say that authority is a condition that is subject to being reinforced by sanctions, while influence usually secures compliance without reference to sanctions. This difference accounts in part for our assumption that interpersonal relations in big organizations tend to rest upon authoritative premises rather than upon influential ones. This is not to say that organizations do not use influence. With the possible exception of those in military organizations, interpersonal relations are usually articulated in permissive terms, but there is little reason to suppose that those concerned are unaware of the relative power disequilibrium. Moreover, aside from other motives for consent such as personal ambition, anxiety reduction, and the desire for group approval, the very fact that an order emanates from someone with higher status and more power tends to induce consent based upon an assumed legitimacy of his role. This is only another way of saying that the very fact of hierarchy in complex organizations encourages compliance.

Obviously authority in organizations does not always function hierarchically. In addition to informal loci of power, there is the fact that technical skill demands recognition. Thus a superior must often defer where technical considerations are decisive. Yet as the experience of the atomic physicists suggests, the control of technical personnel in terms of recruitment, promotions, security, and the ends to which the product will be put is usually determined by authority according to the formal hierarchy. The conflicts between administrators and scientists and researchers on this score are well documented.

An appraisal of authority must also include the fact that big organizations are composed of many subhierarchies, each bound together by authority, interest, and values in a way similar to that in the total organization. Each has its internal power structure headed by a leader who is supreme within his own system, but who is a nonleader when viewed from the perspective of the larger hierarchy. This devolution of power has important consequences. It ensures discipline, since the life chances of those in each subhierarchy are determined largely through representations made on their behalf by such subleaders. As a result, an upward-looking posture characterizes the whole organization. The will of the minority is transmitted downward through the organization by the subleaders, reinforcing their own authority and status vis-à-vis their subhierarchy.

Here the ambiguity of personal and organizational goals may be seen. To retain his position and preserve the hope of future rewards, each subleader must simultaneously promote organization-wide values and yet retain the loyalty of his immediate associates by defending their interests against both competing subhierarchies and neglect by the elite. Although

ambivalence may result, his career is in the hands of the elite, and we can assume that he will give priority to its will, as he must if he is to fulfill his role as an agent for carrying out its policy. He will be measured by the loyalty and affirmation with which organization policies are effected. Thus the tribute that the upward mobile subleader pays for marginal power and localized status is upward-directed anxiety and ambiguous interpersonal relations.

In sum, authority includes legal, psychological, moral, and technical factors. Their relative weights vary with the particular situation, mainly in terms of how manifest and compelling the authoritative stimuli are. Thus the hypothesis: *The more obvious and powerful (structured) the stimuli in a given interpersonal situation are, the more predictable and constant the response.*

Despite the complexity resulting from the interplay of these situational and psychological factors, we can assume that bureaucratic structure produces exceptional probabilities that individuals will defer. We know that the recognition that one occupies a hierarchical position clearly subordinate to others encourages deference. We also know that a positive assumption of authority on whatever grounds enhances compliance. Haythorn found that "when one member of a group was aggressive, self-confident, interested in an individual solution to a task, and showed initiative, the other members of the group showed less of such behavior than they normally did."[11] This tendency reflected the group's desire to avoid conflict. The way that group values are imposed will be considered presently, after we have seen how the organization encourages the loyalty and obedience of its members.

As Donald Calhoun has suggested, this is done by convincing the followers of the legitimacy and rationality of the organization, mainly by equating authority with ethical and ideological principles.[12] Of course, all institutions strive to find some basis other than sheer power for their authority. Evocative symbols and rituals are enlisted to inspire loyalty to the organization. If loyalty is to be thought merited, the values and motives, as well as the routine behaviors, of the organization must be seen as selfless; if possible the organization must appear to be the embodiment of certain universal ideals that are beyond individual criticism. This process may be called legitimation.

Max Weber posited three kinds of legitimacy: legal, traditional, and charismatic. The first is based upon the assumption that the organization seeks the good of everyone and merits support accordingly. Traditional

11 Cited in L. F. Carter, "Leadership and Small-Group Behavior," in M. Sherif and M. O. Wilson, eds., *Group Relations at the Crossroads* (Norman, Okla., 1953), p. 273.

12 I am indebted here and elsewhere to his insightful paper, "The Illusion of Rationality," in R. Taylor, ed., *Life, Language, Law: Essays in Honor of Arthur Bentley* (Yellow Springs, O., 1957).

legitimacy is the belief that the organization and its values are hallowed by age and experience and ought not be challenged by any time-blinded individual. Charismatic legitimacy is based upon an irrational faith in the values and goals of the organization and its leaders. The charismatic personality is able to inspire among his followers a desire for sacrifice and devotion.

Most organizations enlist all of these legitimations in justifying their claims to loyalty, and the appeals are usually articulated in terms of the general welfare. It is necessary, however, for organizations to simplify what is really happening, since their objectives are actually more complex and less disinterested than this. While they do in part seek to advance the common good, they are also concerned with perpetuating the organization and its individual prerogatives and with mediating conflicting demands within the organization. As Calhoun says, however, if mass loyalty is to be maintained, all three activities must be rationalized in terms of the first objective. Since it is impossible to define the general welfare, much less achieve it, the organization is obliged to draw upon another ideological resource, the myth that it is founded upon unquestionable, unchanging principles.

Once these principles are accepted, it becomes possible to attribute any patent shortcomings, blunders, and injustice of the organization to its members, leaving its ideals intact. This sacrificial behavior is seen in the dramatic "confessions" that occur periodically in the Communist party, but mechanisms that differ mainly in degree are employed by most big organizations. Necessity demands that failure be personalized and projected in a way which shows that human error was involved rather than organizational legitimacy. Certain highly self-conscious organizations, among which one can safely include the Marine Corps, the medical profession, and the Foreign Service, exhibit this collective idealization, often evoking exceptional loyalty from enchanted members. By contrast the individual may appear to himself to be ineffectual. The ritual, continuity, and power of the organization reinforce this self-perception.

Another psychological aspect of big organization is the illusion of unanimity among its members. Differences of interest and opinion are ignored in an effort to present a public image of discipline and unity that will enhance the organization's competitive chances. Dissent is confined within the organization. Once a decision has been hammered out, everyone must accept it, since further discussion would impair the desired solidarity. In part, the tendency of organizations to limit participation reflects a desire to avoid the appearance of internal disharmony that active participation entails. The common organizational requirement that communications be cleared through a "public information" agency is germane. The remarks of uninstructed members can thus be dismissed more easily as unauthorized. It follows that only certain individuals are actually responsible

spokesmen. These are its priests, who explain the organization to the outside world, interpret its catechism, and rationalize any disparity between its ideals of service and its daily behavior.

To increase the probability that individual behavior will reflect the unanimity principle, various appeals are invoked. Affirmative stimuli include inspirational calls for loyalty, sacrifice, perpetuation of the organization's ideals, and so forth. Negative stimuli are latent but powerful. The organization depends mainly upon the sensitivity, the learned deference behaviors, the anxiety-reduction needs, and the ambition of the individual. Such psychological mechanisms reduce the need for sanctions. This climate permits us to view the complex organization as an institution of learning which calls upon deep-seated individual needs and experiences to support ends that in point of time and significance are often prior to those of any given individual. In effect the individual's "self-system" of successful accommodation to authority is co-opted by the organization, and the stimuli that initially induced its development are systematically reinforced in ways described below.

Some of the implications of learning theory for organized behavior can now be specified. We suggested earlier that organizations elicited an exceptionally strong tendency to defer and, generally speaking, that it seemed reasonable to assume that the consistency of individual responses was correlated with the power and ease of recognition of stimuli. Psychologically speaking, the very definition of a "structured field" is that stimuli are stable, obvious, and compelling, in the sense that they define appropriate behavior. Learning is a function of perception and motivation, and both depend upon the quality and the number of stimuli, as well as upon individual sensitivity and receptivity. We have also defined bureaucratic structure as a system of manifest, authoritative stimuli, reinforced by known sanctions and a high reward potential. A related hypothesis follows: *Individual responses will be more certain and constant in bureaucratic structure than in so-called "voluntary associations."* To put it another way, big organizations have decided influence on individual behavior patterns, which are defined as a consistent way of reacting to interpersonal situations.

Perhaps the most common kind of manifest and authoritative stimuli are status and prestige indexes. In organizations status and authority are designated by appropriate symbols including title, size of office, accessibility, and income. In this sense the organization presents a "structured field." Such indexes, which differentiate members on the bases of authority, prestige, skill, and seniority, enhance the structured character of organizations by providing a network of signals that curtail spontaneity, limit alternatives, and generally define interpersonal relations. For this reason

status consciousness tends to become a built-in part of bureaucratic psychology, as well as a necessary personal skill.

The present importance of status symbols seems to reflect a change from an economy of scarcity to one of conspicuous consumption. But conspicuous consumption is difficult to achieve today because mass production and productivity have made the symbols of material success available on so large a scale. The resulting disenchantment of once-favored classes is interestingly seen in the Middle East, where the periphery of material benefits is slowly being expanded through industrialization and inflation. There the elite feels deprived, owing to the loss of indexes that once set it apart. In the United States the diminution of this psychic income suggests that subtle, nonmaterial distinctions will become more highly valued, since they will be more difficult to establish.

The social framework of status also includes the fact that its symbols tend to become a substitute for values no longer attainable. The declining opportunity for individual autonomy through self-employment, which reflects the trend toward size, concentration, and difficulty of entry; the employment of the "independent" professions on a salary basis; the devaluation of professional training and increased status anxiety—all seem related. The effort to achieve status through word magic is suggested in the attempts to borrow prestige by assigning status-laden titles to socially devalued jobs: news analyst for reporter, mortician for undertaker, executive for salesman, engineer for all sorts of routine jobs, and the widespread co-optation of the honored symbol "professional."

The American assumption of upward mobility, generation by generation, is thus related to status idealization. A cross-cultural comparison with class-bound European and Middle East societies suggests that in time sheer age, the maturing of the economy, and declining occupational mobility in the United States will tend to aggravate status consciousness, resulting in greater reliance upon inherited distinctions as objective means to status become more difficult to achieve. A free and easy democracy requires a social and economic situation in which there is relatively free access to abundant natural resources. A mature society checkmates this competitive situation as the lessons of power are learned by previously disadvantaged groups, and an uneasy equilibrium between major interests tends to follow. In this milieu big organizations turn to subtle status rewards as compensation for personal dependence and limited mobility. The honoring of seniority is an obvious example, as is the small gap between initial and upper-level incomes in the bureaucratized occupations.

As a rule those who have organizational power possess exceptional status and prestige reinforcements, such as size and *décor* of office, expense accounts, and staff and secretarial assistance (ideally including a handsome

private secretary whose loyalty and maternal protectiveness may achieve Freudian intensity), that formalize access and encourage attitudes of deference. Such stimuli are patent and compelling, and we can assume that the responses to them will be more predictable than in less structured situations. Their effectiveness is increased by the fact that status anxiety is common in big organizations.

In addition to being obvious and authoritative, organizational stimuli are relatively constant. Authority and its symbols are structured so that the individuals who personify it may change, but the *system* of authority relationships remains. Indeed, bureaucratic structure may be defined as a relatively permanent system of authority relationships. As a result there is little ambiguity or uncertainty about rights and obligations which attach to the "position" rather than to its incumbent. In comparison with social and political power, which is often vague and transitory, organizational power is obvious and definable. Moreover, insofar as organized behavior is group behavior, the authority of legitimated stimuli is increased by sheer numbers. The acceptance of organization values by the majority fosters a consensus that makes dissent seem quixotic.

As was discussed earlier in this paper, such conformity responses have a basis in individual learning and experience, namely, in the successive authority relationships that begin in childhood. It may be assumed that the individual develops considerable sensitivity to authority in all interpersonal situations. An example of the resulting pattern of anticipated reactions is the effect of rank insignia in the military. The mere sight of a high-rank symbol, identifiable at twenty paces, evokes a whole battery of conditioned responses from those affected. The relationship is reciprocal; all concerned know what their proper roles are. Deference, degree of familiarity, tone of voice–indeed the whole character of the interpersonal situation is mediated with ease and dispatch by this single evocative cue. For most organizations the operational consequence of such signals seems clear: the more patent and authoritative the stimulus, the more prompt and certain the response. Related functional aspects of status systems include the recognition of individual achievement and the legitimation of formal authority.

An interesting latent consequence of status-directed behavior is an exaggerated picture of conformity demands, which is often dysfunctional because it aggravates the fear of action and responsibility often seen in big organizations. As A. K. Davis shows, the military situation encourages an "affirm and conform" pattern of accommodation, reflecting the overemphasis on authority and status anxiety.[13] This distorted perception re-

[13] A. K. Davis, "Bureaucratic Patterns in the Navy Officer Corps," *Social Forces*, 27 (Dec. 1948), 143-53.

flects the anxiety of the individual to please his superiors. Since the elite is remote and its will in specific instances cannot be known definitely, the individual seeks to anticipate its expectations. As a result such expectations may seem more compelling than they really are. The individual is not inclined to underestimate them for fear of alienating those upon whom his career chances rest, and he thereby increases the burden of his anxiety. This rule of exaggerated response seems to be a common dysfunctional consequence of big organization.

Despite such consequences, the over-all psychological situation is generally economical, ensuring internal discipline, dispatch, and a minimum of overt interpersonal conflict. Bureaucracy's task is simplified because the reactions it evokes are already deep-seated, having been inculcated by a succession of social institutions. Since birth the individual has been conditioned to operate in a structured environment. Noncoercive sanctions including custom, mobility expectations, and potential rewards practically eliminate the use of gross instruments of control. Because obedience becomes almost automatic, its significance is easily overlooked, or it may be repressed as an uncomfortable reality in a society where individualism is a pervasive theme. This notwithstanding, authority relations in any society become institutionalized between parent and child, teacher and student, leader and follower, officer and man, boss and worker, and so on. Although the resulting power situation may be activated by imperative cues, usually the mere presence of an authority figure, his spoken name, or an appropriate stimulus such as a title or military rank is sufficient to provoke desired responses. We have seen that organisms become conditioned to whole classes of stimuli. The patterns of obedience initiated by parents become generalized to accommodate a whole range of such authoritative stimuli.

We can assume that the anxiety evoked by authority sharpens the individual's perception of organization cues. Pavlov was among the first to argue (on the basis of empirical observation in mental institutions) that anxious people acquire conditioned responses with exceptional rapidity and stability. More recent evidence supports this view. Eysenck cites a study in which normal individuals required twenty-five repetitions of a nonsense syllable accompanied by a buzzer stimulus before a conditioned response was established, whereas anxiety neurotics required only eight repetitions.[14] Similarly, a study by Franks comparing neurotics, normals, and hysterics found that conditioning was much faster and more efficient among neurotics. If, as Sullivan insists, most of us spend much of our time trying to reduce the anxiety we already have and to avoid getting more,

[14] E. Eysenck, *The Psychology of Politics* (London, 1954), pp. 260-61.

we can assume that anxiety reduction by deferring to authoritative others will be a common behavior in complex organizations. Because the range of potential responses is thus limited, behavior becomes more predictable.

Since complex organizations are composed of many small groups representing different skills and values, the structure and the psychology of such groups must be considered. For this analysis a selected aspect of group theory seems most useful. While small groups serve as instruments for mediating idiosyncratic personal needs and for wielding informal power, they also contribute to the "structured field" being examined here. It is well known that after an initial exploratory period small groups become stratified; authority becomes structured in a way similar to that in the larger organization. Freud argued that small-group behavior was best understood as an extension of the early family situation in which the father's role of authority was assumed by the group leader. We can safely conclude that each group develops its own social structure and its means of controlling its members.[15]

From the perspective of a given individual, his own group tends to become "the organization." Usually he performs a given task in company with other specialists, organized in a hierarchy on the bases of skill, seniority, empathy, physical strength, or whatever the going indexes of evaluation are. Since his work satisfactions and his life chances are often bound up with this group, the individual may develop considerable loyalty to it, regarding other groups as competitors. He will probably form personal alliances within the group, and he will tend to rank each member. Some individuals will be accorded leadership, while others will be catalogued as followers. The point of reference for such ranking is often the individual's perception of his own status in the group, as well as the degree to which each member seems to have internalized the group's norms.

This process of structuring gives the small group a hierarchical quality, validated by the tacit endorsement of the entire group. The members apparently seek an equilibrium so that anticipated reactions become the basis of interaction. If groups are to function, such structuring must exist. In any informal group situation, once a goal is set certain individuals

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[15] Among others, see W. F. Whyte, *Street Corner Society*, 2d ed. (Chicago, 1955), and his "Status in the Kitchen," in *Human Relations in the Restaurant Industry* (New York, 1948); George C. Homans, *The Human Group* (New York, 1950); L. Festinger, S. Schacter, and Kurt Back, *Social Pressures in Informal Groups* (New York, 1950), chs. v, vi; A. Hare, F. Borgatta, R. Bales, *Small Groups: Studies in Social Interaction* (New York, 1955); Peter M. Blau, *The Dynamics of Bureaucracy: A Study of Interpersonal Relations in Two Government Agencies* (Chicago, 1955), ch. x.

gradually assume positions of leadership; in a relatively brief time the resulting pattern becomes crystallized because it meets both operational and emotional needs. In such situations the individual tends to seek "consensual validation" of his own attitudes by comparing them with those of the group. That is, he tends to look elsewhere, to the group and its authority figures, for cues that define approved opinions.

The individual's deference to group or majority norms has been established by many experimental studies.

A study by L. Coch and J. R. P. French dealing with resistance to change in a factory is also suggestive.[16] Following a slight change in her job, a machine operator produced at a reduced rate of fifty units per hour. Some ten days later, however, she again reached normal production and soon began to exceed the rates of her group. She then became the target of considerable abuse as a "rate buster," whereupon her productivity decreased to the group's level. Three weeks after the change, all the other operators were transferred, leaving this girl alone. Within four days she was turning out eighty-three units per hour, and she produced steadily at that rate thereafter.

Compliance in organizations is thus encouraged by a variety of sanctions, most of which invoke the anxiety-conformity-approval syndrome but vary considerably according to the situation and the personalities concerned. Given dominant values of success and security, middle-class child training and education seem to foster a high degree of adaptive anxiety, discipline, and repression of aggression in outside-the-home interpersonal relations, whereas a lower-class milieu is somewhat more tolerant of aggression. In industrial work situations ridicule, censure, and even blows are used to discipline nonconformants. On the other hand, in organizations engaged in highly technical work requiring considerable education and training (correlated in turn with middle-class social expectations), we find that sanctions are apt to be rather more Machiavellian and that rewards meet status needs to a greater extent than they do economic ones.

Any useful theory must account for such differences, and research in the framework outlined above would have to differentiate among organization members according to class, motivation, educational background, and attitudes toward authority, since these factors play a significant role in accommodation. I would propose three general patterns of accommodation to the bureaucratic situation: the upward-mobiles, the indifferents, and the ambivalents. (There is some evidence that items in the Adorno

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[16] L. Coch and J. R. P. French, "Overcoming Resistance to Change," *Human Relations*, 1 (1948), 512-32.

"F" scale are helpful in identifying each type.[17]) A preliminary sketch of each ideal type follows. Type one is characterized by an ability to identify with the long-range, abstract goals of the total organization and to make these a meaningful basis for participation, in other words, to accept the legitimacy and rationality of the organization. Allied with this attitude is a capacity for action despite conflicting alternatives and contradictory aims; the organization's values are accepted as decisive. An acceptance of the demands and operational necessity of the organization's authority and status systems seems another functional attitude. For example, it is well known that the successful executive tends to regard his superiors as friendly and sympathetic.[18] These formulations permit us to suggest a third major research hypothesis: *Individual patterns of accommodation to the organization are associated with attitudes toward authority and with socioeconomic status.*

Type two, the indifferents, seem to comprise the most common pattern of accommodation. Rejecting majority values of success and power, the indifferent's orientation is essentially *extravocational.* His work is separated from the assumed-to-be more meaningful aspects of life. His references lie outside the organization, which merely provides the income necessary to indulge off-the-job satisfactions; and unlike the upward-mobiles, these activities rarely reinforce his organizational role. His relationship with the organization is essentially an economic bargain in which he sells his time and energy for a certain number of hours per week but jealously guards the remaining time as his own.

The third type of adjustment pattern is to be seen in the ambivalents, who comprise that small minority who can neither resist the appeals of power and success available through the organization nor play the role required to attain them. The ambivalent seems to need security, which the organization's structure and power could provide, but he is temperamentally unable to make the accommodation necessary to obtain it. This conflict seems to reflect inapposite views toward authority and an aggressive sense of individuality which will not permit him to accept the organization as a collective instrument seeking ends that are beyond those of any individual in point of time and significance. He is thus unable to make decisions in terms of organizational premises, exhibiting instead a particularistic point of view which places friendship and similar subjective values above the objective universalistic values that ensure success in the upward-mobiles' case.

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[17] T. W. Adorno *et al.*, *The Authoritarian Personality* (New York, 1950).

[18] Among others, see Burleigh Gardner, "Successful and Unsuccessful Executives," *Advanced Management*, 1 (Sept. 1948), 116-25.

18. NOTES ON A GENERAL THEORY OF ADMINISTRATION

Edward H. Litchfield*

Dean Edward H. Litchfield offers several major and minor propositions which may provide the beginnings of a framework for a general theory of administrative action.

I hope that this essay will add several propositions which may bring us a little closer to a working theory of the nature of the administrative process. I do not believe we have such a theory today. There are urgent reasons for the early development of at least a working theory of administration. Three are particularly compelling.

First, it is virtually impossible to codify our existing knowledge without some conceptual framework within which to do so. Theory is important for this purpose in any field of investigation, but it is crucially significant in an applied field which must ultimately draw together knowledges now scattered through all of the social and behavioral sciences and through the many applied areas of business, public, military, hospital, and educational administration. As a framework for the organization of materials, a working theory is equally needed by the management consultant, the teacher, the professionally conscious administrator, and the research worker.

Second, a comprehensive theory is needed as a guide to research. However tentative that theory may be, it should help to discern gaps in both existing knowledge and ongoing research and thus to further the design of other research efforts. It would also provide working hypotheses as guides to individual research efforts and as vehicles for the subsequent incorporation of research efforts into organized bodies of thought.

Finally, a tenable theory of administration could become an extremely useful guide to administrative behavior. The analytical and intellectually self-conscious practitioner will readily recognize the importance of a broad theoretical framework which he may use as a measure of his personal performance and which may provide a behavioral check list in his day-to-day undertakings. Educators who do not subscribe to the "either you are born with it or you aren't" school will also find it of primary importance in shaping curricula and in guiding potential administrators.

* From *Administrative Science Quarterly*, I (1956), 3-29. Reprinted by permission of the *Administrative Science Quarterly*.

However urgent a general theory of administration may be, it is unlikely that it can be set forth in the near future. Certainly this essay does not pretend to present a general theory of administration. It will attempt to set forth a series of working hypotheses or propositions which may provide at least the beginnings of a framework for a general theory of administrative action. They will serve their purpose best if they are used as targets for future effort.

FIRST MAJOR PROPOSITION: *The administrative process is a cycle of action which includes the following specific activities:*

A. Decision making
B. Programming
C. Communicating
D. Controlling
E. Reappraising

This pattern of actions is found in various forms in all phases of administration. It occurs in policy areas; it is essential to personnel, finance, and other types of resources management; and it is to be found in the executive function as well. The specific activities and the cycle as a whole provide the mechanism by means of which all of the separate functions of administration are carried on. It is at once a large cycle which constitutes the administrative process as a totality and a series of small cycles which provide the means for the performance of specific functions and subfunctions and even for individual technical activities.

In an idealized form it occurs as a logical sequence in which there is a progression from the making of a decision to the interpretation of the decision in the form of specific programs, to the communication of that programmed decision, to the establishment of controls for the realization of the decision, and finally to a reappraisal of the decision as programmed, communicated, and controlled. In fact, however, the cycle often occurs in abbreviated form. Thus the practicalities of programming a decision may lead to immediate reappraisal, eliminating the steps of communication and control. Again, total group participation in decision making may eliminate much of communication. If individual steps are abbreviated or even eliminated, the cycle is nonetheless complete. In fact, the steps probably are there, even though in quite attenuated form.

Many such cycles are in action in the administrative process at any one time. One elaborate cycle may be proceeding at board of directors' level regarding fundamental objectives, while smaller and still sequential cycles may be going forward in finance and sales, and at the same time very immediate, specific, and perhaps abbreviated cyclical actions occur in the office or in the mind of a district sales manager concerned with a particular problem devoid of any policy, methodological, financial, or human relations significance. There is thus a series of wheels within wheels, tangent

now at one point, now at another. The totality is administrative action, and the wheels are similar not in size but in the articulate and inarticulate uniformity of their components.

The grouping of these activities is made cyclical by the presence of the activity of reappraisal, for this brings the sequence back to substantially the point at which it began. Yet while it completes a full cycle the sequence does not necessarily lead again to identical action. If the original decision is precisely reaffirmed, the sequence of the five activities is no more than a revolution around a constant axis. However, if the original decision is modified in the light of evidence presented in the reappraisal, the axis may move and the circle take on a cycloidal form. With the passage of time and subsequent revolutions in the cycle, an extensive cycloidal pattern may develop.

MINOR PROPOSITION: *Decision making may be rational, deliberative, discretionary, purposive, or it may be irrational, habitual, obligatory, random, or any combination thereof. In its rational, deliberative, discretionary, and purposive form, it is performed by means of the following subactivities:*

a. Definition of the issue
b. Analysis of the existing situation
c. Calculation and delineation of alternatives
d. Deliberation
e. Choice

The sequence of activity from definition of issue to choice is again idealized. It presumes rationality and the existence of discretion. It contemplates the opportunity for deliberation, the possibility of calculating alternatives, and the existence of knowledge with which to estimate the situation. It is seldom that all of these factors are in fact present. Yet only if we view the pattern in its idealized form are we able to understand the nature of the parts as they occur individually or in combination.

Definition of the issue is the isolation both of problems (in the sense that a problem is a difficulty) and also of opportunities in which no difficulty is present. Thus it has both a corrective and creative aspect. A problem may require diagnosis, whereas an opportunity may be defined by research. In any event the function of issue definition is the clarification and description of the question at hand. Efficiency in subsequent steps in the cycle is obviously dependent upon the precision with which this first activity is undertaken.

Situation analysis involves a systematic effort to present facts regarding the existing situation where they may be known and estimates regarding that situation when facts are impossible to obtain. This must include a

factual statement of prevalent values when those are part of the situation and relevant to subsequent choice. Many techniques assist the administrator in the performance of this activity. They include accounting, opinion surveys, market analyses, field testing of products, operations research, intelligence reports, and countless other similar analytical tools.

Alternative calculation involves two major steps: first, a systematic isolation and description of known alternative courses of action; and, second, a statement of the consequences of the alternatives where the latter are known. Where they are unknown, they must be estimated. These estimates will often themselves take the form of alternatives. In any event, this distinctive activity is concerned with known facts, assumed facts, and factual statement of values. Here we are assisted by such methods and techniques as economic forecasting, market projections, linear programming, and game theory.

Deliberation is the next step. In it one is concerned with reviewing the issue in the light of what is known in the existing situation and with regard to the alternative courses of action which appear to be available. It involves an assessment of values, an appraisal of probabilities where chance alone is involved, and strategy where knowledge is imperfect. Deliberation approaches rationality as the values become explicit, as probabilities are analyzed, and as risk calculation can be reduced to a mathematical operation.

Having defined the issues, assembled and stated the facts regarding the existing situation, calculated and delineated the alternative courses of action with their known and estimated consequences, and reviewed all in terms of an explicit statement of ordered values, one is then prepared to choose. Choice under these circumstances is influenced by several considerations: first, free will or discretion and, second, the presence of rationality. Thus, a "wise choice" is apt to be one which the administrator had the discretion to make, had the rationality to base upon the known and estimated data at hand, and had the critical faculty to appraise in terms of the relative significance of those data.

In making choices, the administrator must understand that there is not always one right answer. Truth is frequently plural, and therefore the objective in the exercise of choice is rationality and not a pursuit of a nonexistent absolute. Failure to recognize both the plurality and relativity of correctness in decision making may lead to a time-losing indecision and a precarious mental health for those who must choose.

Actually few decisions are made by means of this full sequence of actions. The issue may be so patent as to make definition unnecessary. Often little effort is made to ascertain or estimate facts. Built-in biases frequently result in only the most superficial calculation of alternatives, and deliberation may be short-circuited by unspecified values or an unwillingness or

inability to think in strategic terms. The elimination of certain of the steps may mean poor decisions, or again it may mean that specialized circumstances make one or more steps self-evident or unnecessary.

We must also recognize the extent to which decision making is influenced by limitations upon rationality. The administrator must not only allow for his own irrationality, he must also calculate the actions of others as being both rational and irrational. Thus, our decisions may be partly rational and partly irrational.

MINOR PROPOSITION: *Decisions become guides to action after they have been interpreted in the form of specific programs.*

Decisions must be interpreted by specific programs which provide the direction for detailed operation. These might be called plans, were "planning" not a confused term which is sometimes used with reference to an "outline of alternatives," and in this sense is a part of decision making. Again, the term is used as synonymous with "programming" as the latter term is used here. One may therefore more accurately speak of planning alternatives (in the decision-making process) and of program planning as an activity designed to implement decisions. Program planning rests on a wide range of specific methods and techniques. These include capital budgets, operating budgets, manning tables, organization charts, tables of equipment, and a variety of similar means of translating a decision into specific programs for the allocation of money, manpower, authority, physical resources, and so on. The completeness of the program is a determining consideration in the effectiveness of the original decision.

MINOR PROPOSITION: *The effectiveness of a programmed decision will vary with the extent to which it is communicated to those of whom action is required.*

Communication follows the programming of decisions in cases in which those who must act have not participated in the original decision. Communication is a method by which an individual or group transmits stimuli which modify the behavior of another individual or group. While it is an activity employed in administration, it is obviously broader than the administrative process, for there is communication among individuals who have no administrative relationship to one another. We may therefore say that we are concerned here with the use of the method of communication for the restricted purposes of the administrative process.

Communication in administration involves three primary responsibilities. First, the administrator must establish the channels, the methods, and the opportunities for communicating with all of those above, below, and around him whose actions he would influence. Second, he must establish

channels and provide the opportunity for others to communicate with him. Third, he must assure the existence of channels of communication among all those in the organization who must influence one another if the organization is to achieve its total objectives. Each of these is a deliberate action which he must take. In two instances it is his responsibility to provide structure on the one hand and to utilize it on the other.

MINOR PROPOSITION: *Action required by a programmed and communicated decision is more nearly assured if standards of performance are established and enforced.*

Standard setting and enforcement may be more generally known as "control." Communication was concerned with stimuli which would call up desired responses, and control is concerned with a definition of the desired response and the methods of assuring its occurrence. In other words, control is an action which provides norms which will serve as a guide to the actors and against which to measure their actions. Both standard setting and enforcement are carried on by means of elaborate techniques of control. They may be techniques designed to control basic programs and operations, such as a budget, an organization chart, or a functional statement. Or they may be processive tools such as job standardization, wage and salary schedules, purchasing specifications, or cost and quality controls. All play essentially the same role in the action cycle.

A notable characteristic of control action is its tendency to become an end in itself. Thus we have the familiar phenomenon of the controller who seems more concerned with his accounting mechanisms than with the management purpose which they presumably exist to further. This often results from the fact that there is an internal element of completeness within the control activity. Having set a standard, reviewed performance in terms of the standard, and then enforced the standard, the person performing the action has, in a sense, completed a full and satisfying cycle. Standard enforcement in fact becomes standard realization and, hence, achievement. It is the only action in the cycle outside of decision making which has this organic unity about it which encourages its use as end rather than means.

While the subactions of control are standard setting and enforcement, the primary working methods are determined by the properties of the thing which is controlled. Thus control of people is achieved by means of a skillful manipulation of various types of rewards and punishments designed to appeal to the several motives of the groups and individuals concerned. Control of money comes with skillful manipulation of that resource in terms of its own laws of behavior.

MINOR PROPOSITION: *Decisions are based on facts, assumptions, and values which are subject to change. To retain their validity, decisions must therefore be reviewed and revised as rapidly as change occurs.*

A decision which has been programmed, communicated, and controlled has validity only for the limited period in which the facts, assumptions, and values upon which it was based have retained their original character. Only for such a period can the first four steps in the action cycle be regarded as static. In fact, not only are the facts, assumptions, and values in a state of constant flux, but the fact of decision in itself often brings substantial alteration in the total pattern of circumstance on the basis of which the decision was made. Hence a fully articulated decision—that is, one which has been made, programmed, communicated, and controlled—in itself brings about sufficient change to necessitate its own reconsideration. This is the activity of reappraisal.

Reappraisal is necessitated not only by change but by the possible imperfection of the original decision which time and circumstance may make apparent. New insights may be gained which improve the administrator's understanding of a more nearly correct decision, even though the facts themselves have not been altered. Here we return to a recognition of the plurality of truth as noted in our discussion of the decision-making activity. Thus we reappraise decisions because of our acceptance of the concepts of "contingent universe" and "organic incompleteness" which are implicit in cybernetic thought.[1]

Reappraisal may be accomplished in several ways. In its simplest form it is no more than a review of the original issue in terms of new data, new assumptions, new strategies, and new values which have bearing on the decision but which arise from extraneous sources. Thus, new information about Soviet military production may require the reappraisal of a foreign policy decision which had been based upon different fact assumptions. This may be referred to as a "feed-in" activity. Quite different is the process of "feed-back," which is the essence of cybernetic theory. Here we contemplate the reappraisal of an original decision upon the basis of facts and values which have been generated by and as a result of the original decision. Reappraisal therefore provides for self-generated change and growth.

Whether the reappraisal be "feed-in," "feed-back," or a combination, its function is the same. It is needed to complete the action cycle in order to make it dynamic rather than static. This is the action which induces change and growth. It must be specifically provided for in the action pattern if growth is to be accepted as both constant and necessary. Only

[1] See Norbert Wiener, *The Human Use of Human Beings* (Boston, Mass., 1950).

through reappraisal can administration adjust to the constancy of evolution; otherwise the administrator is apt to pursue a concept of the permanent and absolute. This is a vehicle for incorporating into administration an understanding of stability through change rather than through an artificial staticity.

SECOND MAJOR PROPOSITION: *The administrative process functions in the areas of:*

A. Policy B. Resources C. Execution

A "policy" is a definition of those objectives which guide the actions of a whole enterprise or a significant portion thereof. It is thus distinguished from the general term "decision," which may guide actions without reference to such objectives. The "resources" of administration are four: people, money, authority, and materials. "Execution" is a function of integration and synthesis which is intended to achieve a dynamic and total organism. All functional areas are requisite to the process. Execution divorced from policy is aimless. Similarly, the policy function tends to become remote and sterile unless associated with resources and execution.

MINOR PROPOSITION: *Action in each functional area is accomplished by means of the action cycle previously described.*

The policy function is conventionally referred to as "policy making" or "policy formulation." In fact it is far more. Policies are not only made, they are also programmed, communicated, controlled, and reappraised. It is only in this total sweep of the action cycle that the policy function has full meaning and is satisfactorily distinguished from the activity of decision making.

The action cycle is also the vehicle for the accomplishment of the resources function. In determining the need for money or people, the administrator defines his problem, estimates his situation, calculates his alternatives, makes a choice, and thus in fact makes a decision. In allocating personnel by manning tables, authority by functional statements or charts, or money by budgets, he is in fact programming his decision. Direction of personnel is communication. Organization charts and manuals, budgets and inventories, are forms of control of money, authority, and materials. The final step of reappraisal is provided for in budget analysis and revision and in a whole series of other resource function techniques.

The action cycle is repeated in the executive function. Setting the policies and resources in motion, synthesizing their conflicting values and tendencies, and integrating the resulting management are achieved by a

constant series of cyclical movements from decision to reappraisal to new decision and further reappraisal. Maintaining them in dynamic equilibrium is realized in the same way.

MINOR PROPOSITION: *Each function seeks a value which when realized is its contribution to the administrative process.*

Policy seeks purposive direction for the enterprise. The resource function seeks economy both in the sense of productivity and of frugality. Execution seeks and is evaluated by the degree to which it achieves a state of dynamic coordination. These are the contributions of the three functional areas. Together they constitute an organism whose direction is purposive and whose resources are productively and frugally employed.

MINOR PROPOSITION: *Each function has distinctive characteristics which govern the application of the cycle to it.*

We have observed that policies involve questions of value and fact. Values are plural and facts are contingent. As a consequence the action cycle employed in the policy function is modified. The four resources have different characteristics. People are moved by varying combinations of rewards and punishments. Money is moved by factors of scarcity. Authority has properties which influence the way in which it may be allocated and exercised. The executive function achieves synthesis and maintains a dynamic organism by observing the laws of equilibrium and decay whether they be drawn from modern group dynamics or are as remote as Henri Bergson's "law of twofold frenzy."[2] In each case, the cycle is constant, but it is performed in the context of a function which responds to its specialized properties.

MINOR PROPOSITION: *The functional areas of administration are integrally related to one another.*

We have already observed that each of the functions is requisite to the total process. It is equally true that the areas are integrally related to one another. Obviously policy is the major determinant of the character of the resource and executive functions, but it is also true that resources are important determinants of policy and that execution may be either the realization or destruction of policy. Administrative behavior must be calculated to recognize that a new policy has immediate implications for authority, finance, and personnel. One follows the other automatically. No one can be isolated from the other, for they are in fact a continuum of reciprocating parts.

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[2] Henri Bergson, *The Two Sources of Morality and Religion* (Garden City, N.Y., 1954).

THIRD MAJOR PROPOSITION: *The administrative process is carried on in the context of a larger action system, the dimensions of which are:*[3]

A. The administrative process
B. The individual performing the administrative process
C. The total enterprise within which the individual performs the process
D. The ecology within which the individual and the enterprise function.

Each of these dimensions has both constant properties and variables. We have examined the constants of the administrative process and must now note its variables. Likewise, we must observe the way in which these dimensions are related. In fact, the process which we have examined in the abstract becomes a real thing only in the hands of the persons performing it and in the context of specific total organizations and, in particular, total environments. These three dimensions affect the administrative process by altering its variables. It in turn alters each of them in its impact upon their variables. We thus have a concept of a system containing four dimensions, each of which has a structure comprising a number of variables which interact upon one another.

Furthermore, the other dimensions have no constant impact on the administrative process. At one point the impact of the individual administrator may be decisive and at another time relatively inconsequential. Thus in a highly articulated bureaucracy, the variations among administrators will affect the way in which the process is performed to lesser extent than in a new organization which has been less rigidly structured. In other words, there are not only variables within each dimension but there is variation in the relative roles among the dimensions in this total action system.

MINOR PROPOSITION: *While constant in basic structure, the administrative process will vary in important aspects, depending upon the personality of the person performing it.*

The cycle of administrative action and the functions of the administrative process are constants regardless of who performs them. The manner in which the actions are taken and the functions are accomplished, however, will vary with the characteristics of the individual. These variations in manner are as important as the constancy in structure. The self-contained administrator may deliberate alone, while the new and uncertain executive may take elaborate counsel. Deliberation is present in both

[3] Here the term "dimension" refers to a category of variables.

cases, but the methods of its exercise are importantly different. Or, in estimating the existing situation, a Wilson may collect his own facts, whereas an Eisenhower will assemble information by means of an elaborate staff organization. Different individual administrators have radically different effects upon the whole organization. Authority as a resource may be delegated to many by a generalist, or to a few by a specialist. As a consequence the authority structure will be flat in one case and pyramided in the other. The consequences of these varying ways in which two types of personalities allocate authority are far reaching, but the resource function has nevertheless been satisfied.

MINOR PROPOSITION: *While constant in basic structure, the administrative process will vary in important respects, depending upon the character of the total enterprise within which it is performed.*

The way in which the administrative process is performed will vary with the character of the organization. One-man decision making in an academic atmosphere is less likely than in a family-owned manufacturing organization, yet there is decision making in both cases. Reappraisal may be infrequent in a conservative British textile firm but constant in a young and aggressive corporation like General Dynamics.

The administrator communicates in a different way in an organization with a well-developed, informal structure than he does in an enterprise which has a high turnover rate and which is composed of persons whose backgrounds and associations are quite diverse. Yet the communication activity is there; only the ways of its exercise and the degree of its effectiveness will change. The impersonality of social relations which increases as an organization grows in size and complexity presents problems in communication unknown in simpler organizations.

MINOR PROPOSITION: *While constant in basic structure, the administrative process will vary in important respects depending upon the environment in which the individual and total enterprise function.*

The administrative process will also vary with the physical, cultural, and technological environment within which it is performed. Communication is obviously influenced by a changing technology which eliminates much of the significance of distance. It is similarly influenced by conversational practice resulting from social systems of rank and class. Effectiveness of the control activity may depend upon the financial and psychological resources which the community provides as alternatives to acceptance of a distasteful standard of working norms. Indonesian understanding of "the good neighbor" raises problems in limiting supervisory spans which are missing in societies where efficiency means more and neighborliness less. Controls which may be imposed and enforced in one atmosphere may

be vitiated by the existence of community or professional standards or values which preclude the individual's accepting the control provided by administration. Part of the theory of the Nürnberg trials is closely related to this.

MINOR PROPOSITION: *The types of relationships existing among the three dimensions other than the administrative have an effect upon the administrative process.*

My colleague, James Thompson, has suggested that "there appear to be four major types of relationships which an enterprise may have with organized elements of environment."[4] He notes competition, bargaining, cooptation, and coalition as the primary types of relationships between the dimension of the whole enterprise and the dimension of the environment. He then points out that these relationships between two dimensions have important bearing on the decision-making activity, for they alter the way in which it is carried on and vary the number of the participants therein. Thus the relationships between two dimensions have caused variation in the third, the administrative process. It would appear probable that we may generalize beyond this and say that there are definable relationships among each of the three nonadministrative dimensions and that the variations among those relationships will have consequent bearing upon the administrative process itself.

FOURTH MAJOR PROPOSITION: *Administration is the performance of the administrative process by an individual or a group in the context of an enterprise functioning in its environment.*

The administrative process is a series of interdependent steps which may be isolated and described in the abstract. Administration, on the other hand, is the performance of the process in the specific contexts of enterprise and environment. As such it is primarily behavior, though in other times and cultures it may have been thought of as largely law.

We have already observed that the parts of the action cycle are reciprocally influential, that the functions performed by the administrative process are integrally related to one another. They suggest an interdependence which is increased once the interdimensional influences have been introduced.

This complex of interrelationships probably constitutes a whole, though it is not yet clear whether this entity can be referred to as a "system" with all of the "organic" implications of that term as it is used in the life sciences. There would, however, appear to be a totality in administration (not in the administrative process) which is significant.

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4 "Administrative Process Working Papers" (unpublished Cornell manuscript, Dec. 31, 1955).

MINOR PROPOSITION: *Administration as a totality has definable attributes. They are:*

a. It seeks to perpetuate itself. As a definable complex, administration has many of the characteristics of other total organizations. Like them, its first attribute is its tendency to perpetuate itself.

b. It seeks to preserve its internal well-being. It is sufficiently self-conscious to attempt to protect itself against disruption from within or destruction from without. It is therefore concerned with its own internal workings and the morale and welfare of its participants.

c. It seeks to preserve itself vis-à-vis others. Each individual behavior pattern composing a complete administrative process maintains a competitive relationship with other behavior patterns constituting other processes.

d. It seeks growth. Like all other organisms, it is aware of the fact that it cannot stand still for long but must go either forward or backward. In its dynamic phases, therefore, it normally seeks to grow. Much of the impetus for mergers, for "empire building," and for entrepreneurial effort in general is made not only on behalf of the corporation, or the bureau, or the institution, but also on behalf of a separate and identifiable administration.

MINOR PROPOSITION: *The attributes of the totality of administration have significant effects upon administrative behavior.*

These attributes of totality are really properties of organic compulsion and as such are compulsive as far as behavior is concerned. Thus, the successful administrator seeks internal cohesion among the members of the administrative group. He seeks to keep his group intact. He presses for individual identification with the total process. He stresses competition as a means of preserving his "administration's" relationship to others. In short, he performs in such a way as to attempt to perpetuate the process, maintain its internal well-being, preserve its position among competitors, and, indeed, to help it grow.

FIFTH MAJOR PROPOSITION: *Administration and the administrative process occur in substantially the same generalized form in industrial, commercial, civil, educational, military, and hospital organizations.*

The concept of the universality of administration and of the administrative process has been implicit in much which has been set forth above. It must now be made explicit as a separate proposition. This is particularly important both for the classification of existing knowledge and as a hypothesis for subsequent investigation.

The cyclical development of administrative action, beginning with decision making and moving through reappraisal, occurs in all types of organizations. Similarly, each of them is served by administration through

the accomplishment of the same basic functions in the areas of policy, resources, and execution. Again, the process is no less organic in a hospital than it is in a manufacturing establishment. Finally, the process is but a portion of a larger action system, whether that system occurs in the Department of the Interior or in General Motors. The process becomes a whole as administration when performed by an individual within an enterprise functioning in its own ecological setting.

In every case, there is a constancy in fundamental properties. The differences which exist from one field of application to another are differences which result from the factors suggested in our discussion of the four dimensions constituting action. These are the fundamental differences; the variations in institutional application are derivative. When thus analyzed, however, these more fundamental differences are seen to be but variations in the way in which a constant process is performed or accomplished. They do not argue against a basic universality.

Section B:

THE MAJOR AREAS OF ADMINISTRATIVE CONTROL

The administrator of a business enterprise has aggregate administrative responsibilities and specific areas of control. These areas are cash, inventory, research and development, production processes, marketing operations, and personnel. It is necessary for the administrator to exercise managerial control over these specific areas to manage the enterprise effectively.

In so doing the executive must recognize that the importance of cash forecasting in forward planning ties in the establishment of a continuous balance between the cash position and the other aspects of the plan. The short-term cash plan is measurable against recent actual performance and current trends, while the long-term cash plan is subject to such broad influences as national economic trends, the effect of technological and competitive progress on customer demand, and the development of new products and new markets. These forces direct management into continual reappraisal of manufacturing facilities, methods of procuring materials, labor supply, and future cost-selling price relationships.

When cash budgets are prepared some firms also draw up an application of funds statement. The preparation of both statements helps to spotlight trends through the cash budget

balance sheet. The fundamental purpose of the funds statement is not to tell more about the income-generating and income-measuring processes, but rather to disclose data about the related but distinct task of financial management of the business enterprise.

The inventory management objective of the enterprise should be to maintain balanced, strategically located stocks of inventory available for quick shipment. A concerted program will be required on the part of general, sales, financial, purchasing, and manufacturing management since all will have the same vital objective of customer good will and the addition of new customers who are attracted by progressive inventory management and reliability of source, along with factors of price and quality. The decision and control of finished goods should generally be assigned to the merchandising group, since they are most familiar with customers and their requirements.

One of the major tests of a good inventory control and production planning system is its ability to meet customer requirements based on good sales forecasting and good procurement and manufacturing practices. Usually a company having a high degree of reliability in meeting shipping promises will also have a high profit within the industry.

It is possible to have inventory controls which are not only flexible but also carefully designed and explicit. The task needs special analytical tools; in a complicated business it defies common sense and simple arithmetic. Methods must be employed to take direct account of uncertainty and to measure the response characteristics of the system and relate them to costs. Such methods are the distinctive mark of a really modern, progressive control system. It takes a good deal of research into sales and product characteristics, plus skill in sensing which of the many possible approaches are likely to be fruitful.

Some businessmen are prone to view inventories with distaste, as an apparently necessary drain on resources, something that no one has been able to eliminate but hardly a "productive" asset like a new machine or tool. Actually, however, inventories are as productive of earnings as other types of capital investment; they serve as the lubrication and springing for a production-distribution system. A comprehensive inventory control system should be closely co-

ordinated with the other planning and control activities, such as sales forecasting, cash planning, and capital budgeting, since it affects all of these activities in many ways. The specific steps and timing will vary from one company to another, depending on product and process requirements, but the essentials of an inventory control system can be grouped into three broad classes: long-range inventory planning, short-range planning, and scheduling.

Planning is the key to administrative control. At the company level, it determines the amount of money that can be allocated to research. The research management distributes these budget dollars to fit the particular program. The cost-reporting procedure then gives the management tools to analyze, control, and schedule research activities to the best future interests of the company.

The establishment of a budget does not give the directors of the research and development program any guide for programming their efforts. Such guidance is invaluable for those who must make decisions, direct the orderly progress of the development program, and intelligently plan and control the work of the department. Cost records are advisable so that those responsible for the functioning of the research department can control the expenditures and determine the amount of funds available for subsequent operations. Thus, the financial executives can assist in the direction of the research and development division towards the ultimate goal of all concerned: progress for the organization, growth, and additional profits.

Operations research will help the business executive of the future make decisions more intelligently in various control areas, but the decisions will always remain to be made. The possibility of removing all subjective and qualitative factors must be deemed at the present time to be more a hope than a real possibility, and the construction of completely consistent and logical goals, while a reasonable objective in decision making, may be unattainable. The balancing of the responsibilities to society, consumers, owners, and employees will therefore still be the fundamental task of the executive.

The executive must continue to maintain control over operations. It has been suggested that the relationship of operating profit to gross assets is the best measure of operat-

ing efficiency. Where control of cost cannot be readily measured in terms of dollars, as in the case of broad investigative and research programs in manufacturing, engineering and sales, a project control may be used.

Nothing paralyzes action on the part of executives like excessive analysis of figures. A good general rule is to carry the analysis of breakeven only far enough to give direction and stimulus to effective action on the part of the administrator concerned. Only a few charts should be used to enable the top administrative officials to maintain a perspective view of the enterprise and to direct and encourage effective action on the part of managers down the line. In fact, almost anything an executive wants to know about the operating economics of the business enterprise can be learned by the use of breakeven point controls.

The production process and the administrator have moved into such theoretical areas as the learning curve. The basic theory of the learning curve is simple: a worker learns as he works, and the more often he repeats an operation, the more efficient he becomes, so that the direct labor input per unit declines. What was not known until a decade or so ago is that the rate of improvement is regular enough to be predictable. There is every indication that the learning curve offers a practicable answer to the needs of thousands of manufacturing companies for fairly accurate forecasts of direct labor requirements and productivity, but it is still a new device in a more or less "experimental" stage.

On the marketing side the function extends far beyond sales. It entails cooperation and coordination with other parts of the organization, specifically production and finance. The marketing administrator must take into consideration the other functional areas so as to produce the kind of sales volume and dynamics that will give the company the greatest net income as well as the greatest potential growth. Cost accounting, properly interpreted, is essential to administrators for guidance in avoiding unprofitable sales and seeking to make sales which produce optimum profits. Such things as the allocation of fixed cost by territory should be avoided, because they could produce unrealiable or misleading figures. However, marketing decisions based on figures alone would be ill-advised.

The control of quality is a most important factor in the

manufacture of material products; similarly, quality control is important with respect to the human beings who are engaged in the various activities involved in the manufacturing process. A major factor which should be kept uppermost in mind by those engaged in any phase of personnel quality control or by those contemplating the initiating of any of the techniques involved is that they are dealing with human beings rather than with machines or other inanimate objects. If a company whose top administrators are human-relations minded develops a competent staff of personnel technicians and gives them the authority commensurable with their responsibility, the results in the form of improved quality of personnel should be evident in a relatively short time.

The business firm needs a more adequate measure of organizational performance than it is now getting. Progress in the social sciences now makes these measurements possible. Thus, top administrative officers need measures that provide them with data to fill the current serious gap in the information coming to them and to their organization.

V

CASH AND THE ADMINISTRATOR

19. CASH FORECASTING

A. F. D. Campbell*

Mr. Campbell emphasizes the importance of cash forecasting in this article and describes the steps involved in making such a forecast.

Modern business has found it more necessary than ever before to take a watchful, searching and co-ordinated approach to the future. Forward planning has become one of the most serious preoccupations of top management.

A fundamental element in forward planning is the establishment of a continuous balance between the cash position and the other aspects of the plan. Otherwise, of course, vital parts of it may be encumbered or brought to a complete halt through lack of liquid funds; or conversely, accumulations of cash may be immobilized, with consequent loss of potential earnings.

Normally, the whole forward plan, of which the cash forecast is an integral part, can be set forth in fairly realistic terms and in meaningful detail for several months ahead. Thereafter, the plan becomes of necessity more generalized and may be projected from three to five or more years.

* From *The Canadian Chartered Accountant,* LXX, 4 (1957), 309-12. Reprinted by permission of the Canadian Institute of Chartered Accountants.

The short-term plan, being measurable against recent actual performance and current trends, will bear on those relatively tangible problems already facing the business and demanding immediate attention. The long-range plan is subject to such broad influences as national economic trends, the effect of technological and competitive progress on customer demand, and the development of new products and new markets. These forces direct management into continual reappraisal of manufacturing facilities, methods of procuring materials, labor supply and of the future cost-selling price relationships. In all of this work, the cash forecast plays an important role because it covers an area which is highly sensitive to changes of all kinds.

DETERMINING SALES PROJECTION

The normal starting point of the cash forecast is the determination of the gross sales figures upon which the production, purchasing, facility and most other aspects of the forecast depend. It is therefore desirable that the sales projection be expressed in the greatest degree of detail for which there is logical support. Accuracy in sales forecasting is essential, and it is almost needless to remark that inaccuracy will render the cash forecast quite useless, if not harmful.

The accurate determination of sales requires a thorough survey of the market available to the entire industry for products of a similar or allied nature. It is then necessary to contemplate the share of this market which is feasibly obtainable by the particular business, both on the short and long term. Here consideration must be given to the competitive status of its products in price, quality, reputation, and all other aspects bearing on customer acceptance. The development of such a sales potential will generate a number of questions which are worthy of careful study and management decision. To what extent does the sales potential match the existing manufacturing facilities, marketing organization and manpower supply of the business? Of the available market, what selection of products is best calculated to maximize sales of the profitable lines and still provide assurance of adequate volume to cover fixed charges? To what extent are the risks involved in expansion of facilities justified by the return which the attainable added volume will yield? If an investment is made in additional plant, how long will it take to recover the cash so expended through the marginal cash revenue arising from the added volume? These or similar questions need to be answered in conjunction with the proper determination of projected sales.

For the purpose of the cash forecast it is, of course, necessary to plot the sales projections in terms of gross cash receipts. This procedure may be quite complicated depending on the nature of the business. Frequently,

certain products or portions of certain product lines will be sold to customers whose payment habits vary from normal credit terms. Also, the payment behavior of the same customers may vary on a seasonal pattern throughout a year. Where the company is engaged in export operations, the cash forecast must make allowance for shipping delays and foreign exchange transactions. Since the cash forecast deals in gross revenue, it is necessary to include in the sales revenue such additional items as freight and taxes, where it is the practice for the vendor to pay and may differ considerably among types of products and the geographical destination points of delivery. These are but a few examples to illustrate the factors which are encountered in the accurate forecasting of sales revenue. Once a business has gained experience in this type of close estimating, it is usually possible to develop a number of mathematical formulae, the use of which not only speeds preparatory work but also ensures that no factors are overlooked.

ESTIMATING MATERIAL REQUIREMENTS

After the sales projection, the next most important item in forward planning is usually the estimate of purchased materials. It is an area where the planning techniques can contribute tangibly to improved results.

The sales projection provides a guide so that material requirements can be plotted into the future. With advance knowledge, the procurement of material purchases can be explored more thoroughly, and full advantage can be taken of competitive situations as well as seasonal fluctuations in a variety of commodity markets. Also, negotiations can be discussed in terms of larger quantities at more favourable prices. Therefore, while the buying will be based on the sales projection, there may be a considerable time lag between receipt of cash and the demands for cash disbursements created by the purchasing program. Advantageous purchasing arrangements may frequently cause a heavy drain on cash funds during a period when sales revenue is at a low point. Conversely, cash accumulations from sales may pile up in a later period when the business is realizing on an inventory bought in prior periods.

Hence the cash forecast has a most beneficial influence in the forward planning of the purchasing program. Properly used, it enables management to foresee the need and test the availability of short-term loans or other sources of funds. It also makes it possible to calculate the duration of loans and thereby to negotiate the most suitable and favorable financing arrangements. It transpires that the purchasing program must be modified; this fact is made clear at a sufficiently early stage to allow the adjustment to be made at the least cost to the business.

IMPLICATIONS OF LABOR COSTS

Of equal and often greater importance than the purchasing program are the financial implications of the labor bill. Modern techniques of forward planning are designed to enable a manufacturing company to make the best possible working arrangements for its labor force. While any production program must be kept sufficiently fluid to adapt to unforeseen market conditions, the basic concept will be to maintain a steady flow of work in regular hours. Apart from the highly desirable results forthcoming from a congenial working atmosphere created by a level flow of work, important savings are obtainable when production is turned out by experienced hands and when overtime, training and other penalty costs are kept to a minimum. For this reason, the cash payout for wages may follow a different trend from cash receipts, although both factors are, in the long run, based on the sales projection. Here again the cash forecast fulfils a vital function in providing advance warning of any pressure on the cash resources which might arise from this situation.

The preparation of the payroll section of the cash forecast is worthy of considerable research. The amounts involved are usually large and care must be taken to achieve a high degree of accuracy. Since the payroll takes time to prepare, the net wages will usually become payable several days after the end of the workweek or period. This time lag may cause disproportionately high or low cash requirements in certain months. The payment pattern of the various payroll deductions and fringe benefits also requires careful study. For example, the funding agreement of pension plans may be sufficiently flexible that the business can make payments at times in the year best suited to its cash position.

EFFECT OF OTHER ITEMS

Observations made on the cash forecasting of sales, purchased materials and wage payrolls apply in varying degrees to the many other items which are involved in the forward planning of business operations. Business practice has caused many expenses to be incurred and paid for at times in the year which are not logically co-ordinated with either the needs of the business or its cash position and frequently without any benefits in the form of reduced prices. Sometimes various supplies are carried in stock which are available at the same price on an immediate delivery basis. Perhaps the premiums of insurance policies fall due at times which are inconvenient to the cash position of the company. Stationery, office and many plant supplies may be bought in quantity in, say, January because it has become a habit to let the stock run low at the end of the year, regardless

of the fact that January might be an awkward month for meeting cash payments. Ideally, the manner in which the expense budget is incurred and paid for should be arranged, as far as possible, to suit the trends of the cash position.

CAPITAL EXPENDITURE ESTIMATES

When the receipts and disbursements arising from the trading activities of the business have been plotted on the cash forecast, attention can be turned to the demands which will be imposed on the cash position by the capital expenditure estimates. The accelerated pace of modern business creates high obsolescence not only of tools, machinery, and buildings but also of the geographical suitability of entire manufacturing plants. In the past ten years, the size and frequency of these expenditures has become a matter of major concern to most aggressive companies. While the operating budgets will reflect consequent increases in the depreciation and other amortization costs, the charges are nevertheless spread in the budget over a term of several fiscal periods. The cash forecast, on the other hand, must make provision for the entire outlays involved in new manufacturing facilities on, or close to, the dates of their acquisition. The function of the cash forecast is most important in equating this type of anticipated cash burden with future sources of funds.

The rise in industrial expansion generally has created a wide variety of competitive sources and methods of long term financing. Business can now come closer than ever to a financing plan tailored to its individual needs, although it may find the money market more selective.

20. STRUCTURE AND SERVICES OF THE CASH BUDGET

Grover E. Edwards*

Mr. Edwards concisely outlines the factors entering into a cash budget. The illustrations and the discussion pertain to an actual operation.

After establishing the sales volume and after the operating budget has been approved, many companies have found it necessary to prepare a cash

* From *National Association of Accountants Bulletin*, XXXIX, 3 (1957), 67-73. Reprinted by permission of the National Association of Accountants.

budget. Why? Because, in today's business, it is necessary to know in advance by month, yes, even years, how much cash will be required for plant expansion, operating costs, and for increased receivables and inventories resulting from expected increases in sales volume.

In our company the sales policy committee forecasts the expected sales volume for the coming years and the accounting department establishes the related operating budgets just as is done by many other companies. However, we go somewhat further and establish a budget for a sales volume that is somewhat higher and another for a sales volume that is somewhat lower than the original sales forecast. We also prepare cash budgets based on all three of the operating budgets. The two extra budgets are primarily a safety factor. Our cash budgets may show a drop in profits and a decrease in cash to a dangerously low point and we may need to obtain loans in advance of normal requirements to be on the safe side. On the other hand, the cash budgets may show that an increase in profits will cause an excess amount of cash and we will then be prepared to invest this cash or to pay off any loans that are no longer needed.

In order to prepare the cash budgets, we made certain assumptions in addition to the ones already made for the operating budgets, such as:

1. Minimum cash balance to be maintained.
2. Cash collections.
3. Payment dates.
4. Inventory increases and decreases.
5. Plant expansion programs.
6. Depreciation policies.

MINIMUM CASH BALANCES TO BE MAINTAINED; COLLECTIONS

The minimum cash balance to be maintained must be decided upon before preparation of the cash budget can be started. Although the cash budget, when completed, will enable us to prepare for the large anticipated cash expenditures, it is equally as important to provide an adequate cash balance for the day-to-day fluctuations resulting from normal plant operations. Cash collections, payrolls and other expenditures are usually not spread evenly throughout the budget period. Cash collections may be delayed for some reason or an unexpected expenditure of a considerable amount of cash may be necessary. Consideration must also be given to the minimum balances required by banks or other loan agencies, to maintain credit for future loan requirements.

In order to establish the minimum cash balance we needed, a study was made to determine what our cash balances had been during past periods. Based on this information, we decided on the minimum cash balance for the budget periods. Where two or more companies are to be consolidated for budget purposes, a minimum balance is established for each. Often

the movement of cash between companies is restricted by income tax consideration, by inter-company dividend policies, or other reasons. These must be taken into account.

EXHIBIT I

CASH BUDGET — ASSUMPTIONS

1. Cash balance to be maintained (minimum)
2. Accounts receivable—2/3 of previous month's net sales
3. Notes receivable will increase $100,000 per quarter
4. Inventory: Increased $800,000 11/30/56 and 2/28/57
   Decreased $300,000 5/31/57 and 8/31/57
   Extra inventory required due to addition of another plant
   $300,000 5/31/57 plus $500,000 8/31/57

5. *Plant Expansion program:*

	Land	*Bldgs.*	*Machine tools & other equip.*	*Total*
1st Qtr. End. 11/30/56	$60,000	$100,000	$	$160,000
2nd Qtr. End. 2/28/57		350,000	30,000	380,000
3rd Qtr. End. 5/31/57		400,000	50,000	450,000
4th Qtr. End. 8/31/57		700,000	40,000	740,000

Replacement Program

1st Qtr. End. 11/30/56	$50,000	3rd Qtr. End. 5/31/57	$50,000
2nd Qtr. End. 2/28/57	50,000	4th Qtr. End. 8/31/57	50,000

(Depreciation will offset additions)

6. Cash value of officer's life ins. increase $3,000 per qtr.
   Prepaid pension plan payments

1st Qtr. Due 9/30/56	$50,000	3rd Qtr. Due 5/31/57	$10,000
10/31/56	10,000	4th Qtr. Due 6/30/57	65,000
2nd Qtr. Due 12/31/56	5,000	7/31/57	11,000

   (Others to remain approximately the same as beginning of quarter.)
7. Accounts payable bal.—12/2 per cent of next qtr's. expected volume.
8. Accrued liabilities:
   Accrued commissions—4.1% of previous sales volume
   Cash profit sharing—10% of previous quarter's net profit
   Profit bonus—15.9% of net profit, payable in November
   Profit sharing savings—10% of average monthly net profit for previous quarter
   Accrued payroll—Proportionate to sales volume for following qtr.
   Accrued taxes—Sales taxes proportionate to vol. (.11%)
   Property taxes—$60,000 for 1957, payable 60% in May, 40% in Aug.
   Social security—same as 1955 except for add'l. employees
   Donations res.—5% of net profit before taxes, less $5,000 per month paid
   All others unchanged from 8/31/56
9. Federal income tax—Additions per profit schedule

Payments—1955-56			Payments—1956-57
10% already paid			10% of est. tax due 5/15/57
50% of bal. due	11/15/56	$812,000	10% of est. tax due 8/15/57
Balance—due	2/15/57	812,000	

10. Deferred income on installment notes was 36.6% of total notes receivable on 8/31/56. This percentage has been used for each quarter.
11. Repayment of long-term debt, to maintain the $1,000,000 cash balance.
12. Net worth and capital stock unchanged, surplus increased by net profit after taxes, cash dividends (present plan) $80,000 quarterly on Jan. 1, Apr. 1, July 1, and Oct. 1.
13.

Net sales—Annual Vol.		$36,000,000	Net profit—		$2,700,000
1st Qtr.	20%	7,200,000	1st Qtr.	(7.5% of vol. after taxes and bonus)	540,000
2nd Qtr.	20%	7,200,000	2nd Qtr.		540,000
3rd Qtr.	30%	10,800,000	3rd Qtr.		810,000
4th Qtr.	30%	10,800,000	4th Qtr.		810,000

Note—For this example only one year of operations and expansion program are shown, though normally a budget should be prepared for a longer period especially when an expansion program is undertaken.

When our cash balances decrease below the established minimum, we assume, for budget purposes, that additional funds will be provided by long- or short-term borrowings, whichever may be required. When cash balances increase above the required minimums, the excess cash is applied in the budget to reduce outstanding loans and, after these are paid off, is shown as invested in U.S. Government bonds. Actually the terms of a loan will govern repayments but, for budget purposes, payment of the loans is shown as described above, because the terms are not known when the budget is prepared.

How soon after a shipment is made can we collect the cash—10, 20, 30 or more days? Will sales be made on conditional sales contracts under which payments are extended over a longer period of time, possibly up to several years? To provide us with information in this area, we prepared an analysis of previous monthly accounts receivable balances compared with the monthly sales volume. This comparison showed that the accounts receivable balances averaged 62 per cent of the previous month's sales volume. The study also brought out the fact that our collections average around 20 days from the date of shipment to the date of collection. For cash budget purposes, we decided that the accounts receivable balances should be 66 per cent of monthly sales, to allow for possible extension of credit terms.

Conditional sales contracts, with payments being made on an installment basis or some other basis, will increase notes receivables balances and reduce cash collections. Such sales are often necessary to increase, and sometimes just to maintain, sales volume. Our notes receivable usually increase

EXHIBIT 2

Cash Budget — Balance Sheet

(Thousands of dollars)	*Sept. 1, 1956*	*Nov. 30, 1956*	*Feb. 28, 1957*	*May 31, 1957*	*Aug. 31, 1957*
Assets					
Cash and Gov't Bonds	1,600	1,139	1,000	1,135	1,264
Notes Receivable	1,500	1,600	1,700	1,800	1,900
Accounts Receivable—less reserve	2,222	1,600	1,600	2,400	2,400
Inventory	7,500	8,300	9,100	9,100	9,300
Total Current Assets	12,822	12,639	13,400	14,435	14,864
Plant and Equipment—at cost	7,435	7,645	8,075	8,575	9,365
Less Depreciation	(3,608)	(3,658)	(3,708)	(3,758)	(3,808)
Other Assets	450	393	391	384	311
Total Assets	17,099	17,019	18,158	19,636	20,732
Liabilities					
Accounts Payable	800	900	1,350	1,350	900
Accrued Liabilities	1,141	691	837	1,237	1,432
Federal Income Tax	1,624	1,397	1,170	1,755	2,340
Total Current Liabilities	3,565	2,988	3,357	4,342	4,672
Deferred Income	549	586	622	659	695
*New Loans	—	—	274	—	—
Reserve for Contingencies	500	500	500	500	500
Net Worth					
Capital Stock	2,500	2,500	2,500	2,500	2,500
Surplus	9,985	10,525	11,065	11,875	12,685
Less Cash Dividends	—	(80)	(160)	(240)	(320)
Total Liabilities and Net Worth	17,099	17,019	18,158	19,636	20,732

* New Loans is balancing figure to maintain cash at minimum balance.

during the winter season due to promotion of three basic credit plans, generally referred to as floor plans, longer terms and tonnage payments. They are as follows:

Floor Plans—We make shipments of machines to our distributors during slack seasons, requiring payment to be made either when a sale is consummated or three to four months from date of shipment on an installment plan basis, whichever is the earlier. Discounts are allowed

if total payments are made on or before due dates of the installments and interest is charged if not paid by due dates.

Longer Terms—We increase the length of time before a note is due, either on a single-payment or on an installment plan.

Tonnage Payments—Under this plan, a certain dollar amount is payable based on each ton of material handled.

Cash collections include not only collections from normal sales but the collections of royalties, engineering fees and dividends from affiliated or subsidiary companies, interest on notes receivable, and other miscellaneous income items. In addition, the cash made available through long- and short-term loans must be included.

PAYMENT OF LIABILITIES, INVENTORY CHANGE; PLANT AND DEPRECIATION

The payment dates of suppliers invoices, payrolls, profit-sharing plans, pension plans, plant expansion programs and federal income tax should be scheduled. We consider it generally desirable if cash is available to pay on a 10-day basis, especially when discounts are involved. For our cash budget, we consider all suppliers' invoices to be on a 10-day basis and figure payments for a given month to be one third of the previous month's purchases and two thirds of the current month's purchases. All of our payrolls are considered to be distributed equally throughout the budget periods, even though paying our factory payroll every two weeks may cause them to fall unevenly in the budget periods. We feel that the variation which results is not significant. Our pension plan premium payment is a substantial figure and the date for this payment must be scheduled. Federal income tax payment dates must be scheduled, along with payments for contractor's invoices for the work completed in an expansion program.

In a seasonal business such as ours, it is necessary to plan for inventory increases during certain months of the year and on decreases during other months. During the period of low shipments, from October throughout February, management must decide on the level of production which is to be maintained. The desire to maintain a stable working force with relatively steady hours of work and the degree of risk which management is willing to assume in order to be prepared for heavy demand during the construction season, are prime factors in this decision. Having decided on an optimum level of production and assuming the sales volume already estimated, it is quite simple to determine the inventory increase and later decrease. We do this by taking the difference between production volume and shipment volume and then converting the sales value of the

EXHIBIT 3

CASH BUDGET — APPLICATION OF FUNDS

(Thousands of dollars)	*Quarter Ended — Nov. 30, 1956*	*Feb. 28, 1957*	*May 31, 1957*	*Aug. 31, 1957*
Funds Provided by:				
New Loans		274		
Net profit before Tax	1,125	1,125	1,688	1,687
Decrease in Accounts Receivable	622			
Decrease in Inventory—Plant I	57	2	7	73
Decrease in Other Assets			300	300
Increase in Accounts Payable	100	450		
Increase in Accrued Liabilities	97	269	577	396
Increase in deferred income	37	36	37	36
	2,038	2,156	2,609	2,492
Funds Applied to:				
Repayment of Loans			274	
Increase in Notes Receivable	100	100	100	100
Increase in Accounts Receivable			800	
Increase in Inventory—Plant I	800	800		
Increase in Inventory—Plant II			300	500
Increase in Other Assets				
Purchase of Plant & Equip.—Plant I	50	50	50	50
Purchase of Plant & Equip.—Plant II	160	380	450	740
Less Depreciation	(50)	(50)	(50)	(50)
Decrease in Accounts Payable				450
Payment of Cash Profit sharing	61	54	54	81
Payment of profit-sharing savings	56	54	72	81
Payment of profit bonus	385			
Payment of local taxes			36	24
Payment of accrued donations	45	15	15	15
Income Taxes	812	812	293	292
Dividends	80	80	80	80
	2,499	2,295	2,474	2,363
Excess Funds Provided (Applied)	(461)	(139)	135	129
Cash—Beginning of Period	1,600	1,139	1,000	1,135
Cash—End of Period	1,139	1,000	1,135	1,264
Increase (decrease) in cash position	(461)	(139)	135	129

difference to cost through use of an average gross profit percentage. Inventory requirements for new plants must be determined and allowances for them included in the cash budget.

Plant expansion programs usually run for a period from one year to several years. This type of expenditure requires a great deal of planning, not only for the program itself but for the cash requirements. The timing of construction of buildings and the delivery dates of machinery must be carefully scheduled so that, when the invoices are submitted from the contractors or suppliers the cash will be on hand. To assist in the preparation of our budget, we plotted, by fiscal year quarters, the proposed scheduling of payments for the expansion program.

The method of depreciation used for tax purposes is important in a cash budget. The faster write-off allowed by the government under the new declining-balance method and the sum-of-the-digit-method will give a quicker return of working capital. We use the declining-balance method on buildings because no salvage value is required. On the other fixed assets, we have found from experience that salvage values are insignificant. This combination of methods gives us the quickest return of working capital under the presently allowed methods of depreciation.

USEFULNESS OF APPLICATION OF FUNDS STATEMENT

At the same time the balance sheet is being prepared for the cash budget, we also prepare an application-of-funds statement. We find that carrying through both statements simultaneously helps to spotlight changes and provides a check on the accuracy of the compilation of the figures.

ASSUMPTIONS AND RESULTING BUDGET STATEMENTS

To further illustrate the prerequisites for preparing a cash budget, Exhibit 1 shows the various assumptions it was necessary for us to make. From these assumptions the Cash Budget Balance Sheet (Exhibit 2) and Application of Funds Statement (Exhibit 3) have been prepared. Although figures are hypothetical, they are typical for a business of our type.

The length of the budget period depends on several factors, including the purpose the cash budget is to serve, the financial condition of the company, and the opinion of management as to the practicability and accuracy of estimating. Should the cash balance be low, an estimate of cash receipts and disbursement may be necessary on a weekly, or even a daily basis. However, a firm with ample cash may develop a cash budget by quarters, by six-month periods, or by years, whichever is considered necessary. Each company will have to establish its own budget periods according to the desires of top management.

21. REPORTING ON THE FLOW OF FUNDS

Maurice Moonitz*

Professor Maurice Moonitz discusses the statement of sources and applications of funds in some detail, including the bothersome definition of "funds." The article is essentially a complete exposition of this important report.

In the conduct of an enterprise, management has two major financial tasks of importance to accountants, namely, (1) to operate the enterprise profitably; and (2) to finance the activities of the enterprise and to keep it solvent. In the case of nonprofit activities, the statement of the first task should be modified to indicate that management is charged with making the enterprise perform within its prescribed limitations, such as a budgeted amount of expenditures.

With respect to the first task, accounting has done a good job. That is to say, the necessity of a formal report on the results of operations is widely recognized, and the numerous problems involved in its preparation have received close and earnest attention among all groups and at all levels. With respect to a report on the way management has discharged its second task, our performance is less satisfactory. It is true, of course, that both the flow of funds into and out of an enterprise, and the effects of its financing activities, are recorded in the books, but a formal statement or report is typically not prepared.

The statement of the sources and the applications of funds is an attempt to report on the second task of management, to fill a gap usually left open in the typical published report. The statement is, therefore, a supplement or addition to the conventional battery of statements, not a substitute for them in whole or in part. Assertions, for example, that a funds statement is better or worse than an income statement are unfortunate. The two statements have different functions; both suffer from attempts to set them up as rivals.

The need for a statement to report changes and movements not clearly reflected in the balance sheet and the income statement has long been felt. In this country, the attempt to construct such a statement is usually dated from the publication in 1915 of William Morse Cole's *Accounts: Their Construction and Interpretation.* In that book, Cole described his "where-got-where-gone" statement. But progress was slow. In 1929, Myron M.

* From *The Accounting Review,* XXXI, 3 (1956), 375-85. Reprinted by permission of the publisher.

Strain wrote in his *Industrial Balance Sheets* (page 132), "The statement of application of funds had best be described, as it is one of the most useful of accounting statements and deserves frequent use; but it may be dismissed briefly, because it does not get it. This exhibit details the sources from which all the funds used during a fiscal period were derived, and describes the uses to which they were put. It is a striking and significant interpretation of the changes that have taken place in financial position between two periods." Hector R. Anton, in the October, 1954 issue of the *Accounting Review* has published a report, "Funds statement practices in the United States and Canada." Anton notes that, according to his survey, 68 per cent of the companies involved used a funds statement in some way or other, but that only 19 per cent included such a statement in annual reports to stockholders.

The two managerial tasks under discussion are, of course, related. It is sufficient for present purposes merely that they are not identical. As a matter of fact they tend to merge into a single problem or task over the entire life of an enterprise, or, as a practical approximation, over a substantial time period. That is to say, over the long pull, a profitable concern will also be a solvent concern, although the reverse proposition, namely, that a solvent concern will also be profitable is manifestly not true. Over a relatively short period of time, however, profitability and solvency are almost independent of each other, sometimes almost antagonistic goals. Numerous cases are at hand in which enterprises expanded rapidly and profitably, but with a tremendous strain on working capital in the form of overextended receivables, swollen inventories, top-heavy current debt, and a marked shortage of cash. Similarly, other cases exist of concerns which are unprofitable for several years on end, yet actually improve their debt-paying ability in the process of contraction. The apparent paradox of profitability and solvency moving in opposite directions is not new, nor is it real in the sense of persisting indefinitely. But in the short-run, the two attributes pose two distinct problems; it is helpful to prepare accounting summations of them at frequent intervals.

To follow the point just made as to the relationship between profitability and solvency, we comment on the functions performed by the balance sheet and the income statement. The initial balance sheet of a newly-formed concern is usually also a good statement of funds—it reflects among the assets the results of the applications of funds acquired from the sources listed among the liability and proprietary items. Since operations have not commenced, the problem of profit-measurement does not arise. As a practical approximation, even a balance sheet prepared a little later on will also serve as a statement of funds. For example, this would be true in the case of a company with an extended development period during which little or no revenues arise, followed by an operating period in

which additional development work was negligible. But at some relatively early point along the way after operations have begun, the balance sheet, standing alone, begins to lose its function as a funds statement.

At the other extreme, an income statement for the whole life-span of an enterprise would serve as the backbone of a funds statement covering the same time-interval. It would not be complete, because, to the revenues (sources) and expenses (applications) detailed in the income statement we would have to add at least (a) the long-term borrowings and repayments, (b) the issues and redemptions of capital stock, and (c) the dividends declared. But the combination of the items just listed would produce an eminently satisfactory funds statement, without the intervention of a balance sheet. Notice that even the depreciation charge becomes an application of funds in this statement, because over a long enough period of time the summation of depreciation charges approximates quite closely the actual investment in the corresponding assets. As in the case of the balance sheet, some practical approximations can be introduced. For example, an income statement covering 50 years, supplemented by data on long-term financing and on charges and credits to surplus, would undoubtedly be acceptable as a funds statement. But as the period covered by the income statement was shortened, the need for adjustments or modifications of some kind would begin to be felt in order to convert the income data into funds data.

As a consequence, neither the balance sheet nor the income statement taken alone will give the story of the financial flows for the relatively short periods of time (one year, five years, ten years) covered in reports submitted to stockholders or prepared for top-management review. But these considerations with respect to the two conventional statements as potential exhibits of the flow of funds are worthwhile for two reasons, (1) they indicate why a separate statement of funds is ordinarily desirable or even necessary for a complete reporting, and (2) they indicate the limited but by no means rare cases in which one of the conventional statements will double in brass and serve the purpose quite adequately of a complete reporting on management's performance of both tasks.

II

According to Anton,[1] "in essence, funds analysis is the study of the flow of funds into the business unit and the uses for which such funds flow out during the same given time period." External transactions, then, are involved; so-called internal transactions, or transfers, amortizations, and accruals, do not constitute part of the funds flow. This emphasis is both

[1] Hector R. Anton, *A Critical Evaluation of Techniques of Analysis of the Flow of Business Funds.* Unpublished Ph.D. dissertation, University of Minnesota, 1953.

proper and important; in fact it constitutes the first principle underlying the statement. All the examples of funds statements that I have seen that are internally consistent, logical, and useful in throwing light on the financial activities of a concern make this distinction in some form or other.

To help visualize the problem, a classification of financial flows is attached as Exhibit "A." Basically sound, the classification is not put forward as being necessarily the best one that can be devised. The purpose of the classification at this point in the discussion is to make fairly concrete the kind of thing we are talking about. A good funds statement, then, would include some or all of the items included in this classification; it would exclude other kinds of items found in the accounts of an enterprise or in its conventional accounting statements. For those who like to play with permutations and combinations, this classification is material for your recreation. Just by way of illustration, let us take the conventional form of funds statement as it has appeared recently in some annual corporate reports, that is to say, a statement accounting for variation in net working capital. Such a statement would show explicitly, if at all material, items 1, 2, 5, 6, and 7 under sources as well as under applications; these items might be shown "broad" or "netted." Items 4 and 4(a) under both captions would be combined in a net source of funds from operations (i.e., profit before depreciation and other "nonfund" charges to operations); item 3 would probably not be shown at all but instead would be buried in net working capital itself.

If it has escaped attention, one other characteristic of the classification should be stressed. Each item in the classification constitutes part of a "flow," a movement, and refers to the amount received, for example, from customers during a given time period. None of the items is a balance on hand at any point of time. The scheme is therefore incomplete because it does not tie into anything. But it can be made complete (in the logical sense) by relating it to a "funds balance" at beginning and end of period; this can be done in several ways. One form which appears satisfactory is appended as Exhibit "B."

Before the formal, technical problems of the statement are discussed, a word of caution may be in order. It is easy to become overly enthusiastic about the funds statement, an enthusiasm not justified by the capabilities of the instrument. True, the funds statement does supply information not otherwise available in conventional statements, but remember that it "reverses the accruals" and ignores "internal transactions." Therefore, in at least one respect it is a cruder device than an income statement or a balance sheet. The "cash-profit" approach of some discussions of this problem can easily be overdone, and raise more issues than it resolves.

The positive uses of the funds statement and the reasons for the recent upsurge in its popularity are interesting. For one thing, the recent inflationary movement in this country, associated with a high level of business activity and high tax rates, has posed financing problems on a scale so large as to constitute really new problems to American business. A statement of source and application of funds becomes useful in explaining why a net profit of a million dollars is not identical with an increase in funds of the same amount, available to increase dividends or raise wages. For another thing, the rapid changes of prices in an inflation make comparisons of income statements difficult; a flow of funds analysis may help by submitting a more elementary, less sophisticated type of statement in addition to the income calculation. Finally, a further use, widely employed by economists, and one in which accountants ought to develop an interest, is to reveal "distributive shares" in the output of a concern or an industry—how much "take-home pay," for example, does labor actually get, how much do the suppliers get, how much to creditors, stockholders, government, etc. Properly handled, a statement of funds is better adapted to the dissemination of this type of information than the conventional income statement with its highly abstract, sophisticated cost allocations and estimates, and its completely different orientation.

III

We now proceed to the more formal aspects of the topic. Foremost among the problems involved is that of a fairly precise definition of "funds." A definition is necessary not only to satisfy the niceties involved, but also to assist us in the preparation of the statement and in the resolution of new or difficult problems. A definition of funds provides this assistance by supplying a framework for the whole project, giving us a beginning and an ending balance into which the fund flows must fit or be reconciled, and thereby leading to a second "principle" by which to decide whether or not to include a financial event.

The conventional statement of funds, as it has appeared in published annual reports of the last ten or fifteen years, will serve as a starter. Simply on the basis of frequency of appearance, little doubt exists that "funds" in these reports are defined as identical with "net working capital," that is to say, the difference between current assets and current liabilities. This definition has the virtues of simplicity and of reliance on other widely-used concepts, namely, current assets and current liabilities. These virtues we will stress at the moment; its defects will be revealed later.

Certain consequences flow from the definition. First of all, it establishes the content of the statement of funds—the statement must explain the

change, increase or decrease, in net working capital during the period under review. Secondly, and perhaps of more importance, it provides the basis for consistent and logical answers to any question that may arise with respect to the inclusion or exclusion of a financial event, because any external transaction that increased net working capital is, by definition, a "source" of funds, and any external transaction that decreased net working capital is, for the same reason, an "application" of funds.

For example, under this conventional definition of funds, a stock dividend should not be reflected in a "funds" statement because a stock dividend does not involve any net working capital account in either its debit or its credit aspect. By contrast, a cash dividend, when declared, is an application of funds because it results in a credit to dividends payable or to cash, either of which reduces net working capital, and is therefore a part of the funds flow. Similarly, a dividend in kind, if it is payable in some current asset, also reduces net working capital and belongs in the funds statement; if, however, it is payable in a noncurrent asset (for example, the shares of stock of a subsidiary corporation) no working capital account is involved. As a consequence, that transaction is not logically a part of the funds flow.

The definition adopted also helps resolve questions with respect to amounts to be reflected and their classification, as well as with respect to the type of event to be included. Suppose, for example, that a substantial portion of plant is sold for cash at a loss. Ordinarily, the financial effect of this transaction will be reflected in the appropriate property accounts, their related depreciation allowances, and in an account reflecting the loss on sale of property. It may also involve offsets to income taxes. Two points seem clear enough, (1) the event provided funds, and (2) the amount to be reflected in a funds statement is the amount by which net working capital increased, in this case, the amount of cash received on the sale. But this amount is no longer reflected in a single account; therefore the bits and pieces of the transaction, as they are distributed through the property accounts, the depreciation allowances, the loss account, and possibly the related tax effects, should all be combined into one figure to show the increase in net working capital, the "source" of funds.

But the definition of funds as identical with working capital apparently possesses certain disadvantages. Symptomatic of these is the recent experimentation with "cash flow" statements in published annual reports. For example, United States Steel and American Phenolic have presented two funds statements, one of conventional type, consisting of a schedule of changes in working capital during the year, and the other purportedly showing the flow of cash in and out of the business. These two state-

ments, as published in the 1952 report of American Phenolic Corporation, are appended as Exhibit "C."

A record of cash receipts and disbursements, with the receipts classified by origin (e.g., from customers, issues of capital stock, borrowings from banks, etc.) and the disbursements by object of expenditure (e.g., to suppliers of materials, employees, stockholders, bondholders, etc.), while useful in its own way and undoubtedly a form of "funds" statement probably is overly-narrow in its orientation. A better balance would be achieved if funds were defined somewhere between the narrow extreme of cash and the broad extreme of working capital; a useful middle point is the concept of "net money assets available for disposition." Concretely, this concept consists of the sum of cash on hand and in banks, marketable securities held as secondary cash reserves, and current receivables, less the current liabilities that will be paid by quick assets in the near future. In brief, funds become identified with cash on hand plus cash in process of collection minus checks in process of being written. Where bank financing is important, as in the American Phenolic case, bank loans can be excluded from the category of "funds" and treated as a source or application.

A comparison of the conventional definition of funds with the one proposed above will indicate that the only major difference between the two is the treatment of inventories. Under the conventional definition, inventories are included as a part of net working capital, the funds balance itself. In the proposed definition, inventories are treated as a source of funds, when they are sold to customers, and as an object for the application of funds when debts are incurred to move them from the materials stage through process and into finished goods. This latter treatment seems more in accord with the function of inventories in a going concern. Of course, when the "inventories" are in reality indistinguishable from receivables, they should be classed with the purely financial items. The reference here is to the output of a gold or silver mine or the work done on a cost-plus-fixed-fee (CPFF) contract.

Regardless of the definition of "funds" adopted, certain types of financial events that ought to be included will be omitted, unless the first principle previously enunciated is invoked. This first principle states that we are dealing with external transactions. The type of transaction that is likely to be left out, if attention is focussed too narrowly on the definition of funds, is the barter deal or the deferred-payment transaction. Take the case of a building acquired for 10 per cent cash and 90 per cent first-mortgage bonds. Whether funds are defined narrowly as cash, or less narrowly as "net disposable money assets," or broadly as net working capital, only the 10 per cent down-payment results literally and directly in a decrease (application) of funds. Still, the whole event is important, and, under the first principle, should be reflected by showing an applica-

tion of the full amount of the purchase price of the building and a source of funds equal to the bonds accepted by the vendor. When the bonds are retired, the statement for that period should show an appropriate application of funds to retire long-term debt.

A rationale in the form of a presumed hypothetical intermediate cash transaction is theoretically satisfactory. Under this explanation, the event is treated as though the bonds were issued for cash, and the cash used to buy the building. But this type of explanation leaves the way open for other hypothetical interpretations which may not be so acceptable, and furthermore, is unnecessary. It is better, with any definition of funds, to refer back to our first principle, namely, that we are dealing with relationships between the concern and the outside world, and include these barter deals and deferred-payment arrangements explicitly, rather than by the back-door of hypothetical intermediate transactions.

Certain other characteristic problems arise in the preparation of a funds statement. Noncash gifts and subsidies, for example, have no impact on funds; yet the amount involved may be material and the reporting essential to a full disclosure of the way in which the enterprise is being financed. These gifts and subsidies should be included as (a) funds provided by the donor and (b) applied to the object received. Gifts or subsidies in the form of cash do increase funds, however defined, and will appear in a funds statement.

An example of this type of problem comes to mind. A hospital, newly-formed, acquired equipment for cash, and then was reimbursed for its actual expenditures by a governmental agency. In this form, no difficulty arose in the preparation of a funds statement—the hospital had clearly applied funds to acquire equipment; the hospital had clearly received funds from an outside source when it was reimbursed for its earlier outlays on equipment. But suppose the governmental agency had acquired the equipment itself and made the gift (subsidy) to the hospital in kind. No cash (or other fund account) would have been involved on the hospital's records. Yet it seems clear that the two forms lead to identical results; the substance should prevail in the preparation of a funds statement as in the case of any other accounting report.

One additional observation may be useful. Notice that we are not concerned with the classification of a gift or a subsidy as an increase in capital or in earnings, or in neither. We are concerned solely with the fact that a financial event occurred involving the entity and an outsider; when we report that event, we have fulfilled the requirements of a funds statement. In the related but not identical problem of income measurement or the reporting of financial position, the question of the proper classification of a gift or subsidy as between capital and income will have to be faced. But

not in a funds-flow analysis. As a consequence, a funds statement will reflect the event in identical fashion, regardless of the manner in which it was reflected in the records—records which are conventionally designed primarily to assist in the determination of periodic income.

Another problem is the treatment of depreciation and other amortization. No extended analysis of this warhorse is necessary; instead a few observations will be made. First, the application of funds to the depreciable or amortizable item is reported in the period of its acquisition. Second, depreciation itself is omitted from the funds statement because it is a cost or expense, properly recognized in the measurement of income, which does not require the application of funds, however defined, in the current period. Third, any attempt to show depreciation as a "source" of funds is awkward, unnecessary, misleading, and just plain wrong. The reference here is to the widespread practice of adding back depreciation to the net profit figure to get the amount of funds provided by operations. This is a worksheet adjustment, and does not belong in a formal statement. The figure we are after, and that we usually get by this adjustment, is the amount of funds provided by operations *before* deducting a nonfund item such as depreciation expense. Fourth, the depreciation adjustment may be incomplete in a manufacturing concern—a considerable amount of depreciation may be tied up in inventories, and ought to be reversed.

Another problem is the tendency to want to reverse the entries for estimated uncollectible receivables. Except where funds are defined as cash, and the funds statement accordingly becomes a report of cash receipts and disbursements, this type of reversal is not warranted. Current receivables are a part of funds; the allowance for bad debts is an attempt to reflect those receivables on a net collectible basis, and should therefore be left alone in a funds analysis. Perhaps the difficulty arises when the analyst recognizes quite correctly that the charge to income for bad debts is not an application of funds. But the proper treatment in this instance is not to reverse the entry as a nonfund adjustment, similar to depreciation. Rather the charge to income should be interpreted as a revenue-deduction item, a correction of an otherwise overstated revenue account. If the bad debts debit is so interpreted, and it is the correct interpretation, no difficulty on this score will be encountered in the preparation of a funds statement.

A loss on the conversion of any funds item constitutes an outflow of funds, a diminution in the "pool" of homogeneous elements; as a consequence the loss would usually be classified as an "application" of funds. For example, assume that marketable securities, held as a secondary cash reserve, and reflected in the books at their cost of $100,000 are sold this period for $95,000. Assume also that in this same period a theft of $5,000

cash takes place, without recovery of any sort. Each loss of $5,000 represents an "outflow" of funds, and should be so reported, even though the events themselves were unplanned and undesirable. The related case of a gain on the conversion of a funds item is clearly an inflow of funds, classified usually among the sources.

The treatment of inventories as a source of funds or an object of their application has already been urged primarily on the basis that inventories, in the usual case, are too important to be buried in a net working capital figure and require substantial outlays to move out to customers.[2] The sales figure is of course identical with the funds provided by customers during the period. The application of additional costs to process the inventory in the current period can be calculated in total by a simple formula, namely, the cost of goods sold plus the difference between the ending and the beginning inventories. In the case of the so-called actual cost systems, this formula will always hold regardless of the method of inventory pricing employed, whether cost or market, first-in, first-out, last-in, first-out, or average cost. The formula yields a total figure; it will not give the breakdown of the costs among labor, materials, supplies, etc.

In the case of a standard cost system, the formula just given will also hold, provided the variances are closed out at the end of the period to inventories and to cost of goods sold. If the variances are instead carried direct to income, the formula, as it stands, will calculate funds applied *at standard*, which is presumably not satisfactory in a funds analysis. Consequently, the formula should be expanded to include "plus or minus the standard cost variances."

As the last problem to be discussed, consider the situation when a previously non-current item becomes current, without an actual transaction with an outsider. Specifically, consider the case of the current portion of a serial bond issue. Each year a new series is detached from the long-term debt and placed among the current debts, indicating payment in the near future. In a funds statement, this amount is treated as an application for the same reason that a dividend declaration is so treated, namely, that payment in the normal course of events is automatic in the short-term. As a consequence, the pool of net disposable money-assets or of net working capital is diminished. In either case we have a clear case of an event giving rise to a decline in funds.

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[2] Where the finished goods or merchandise is virtually as good as cash the conventional inclusion of inventories in the funds total is satisfactory. In addition to inventories of precious metals and costs tied up in CPFF contracts, inventories of commodities for which a highly-organized spot and futures market exists would qualify for inclusion. The case for inclusion is especially strong if these types of inventories are stated at net realizable value instead of at cost, because cost does not, except by coincidence, measure the inflow of funds from the holding of highly-marketable inventories.

IV

In the process of preparing the funds statement, several methods are available. Vatter, of the University of Chicago, has proposed the derivation of data from direct posting to T-accounts.[3]

Others have stressed the desirability of inserting a summary analysis of nonfund accounts in audit working papers, thereby also obtaining directly the necessary data, as under Vatter's proposal, but without the intervention of actual accounts. This procedure is illustrated in Finney and Miller, *Principles of Accounting: Intermediate*, 4th Edition, and in Holmes and Meier, *Intermediate Accounting*, Revised Edition. The most widely-used method, however, is the process of adjusting changes derived from comparative balance sheets, as supplemented by an analysis of income and retained earnings.

If this procedure is followed, certain technical problems arise which are similar regardless of the definition of funds employed. These may be summarized briefly as follows:

1. Reverse the differences in account balances representing transactions not involving funds; (example: the depreciation entries)
2. Reinstate any transactions involving funds that are suppressed in the usual accounting process; (example: sale of a non-current asset)
3. Combine and reclassify the remaining items to bring the bits and pieces of funds data together.

In the worksheet itself, the funds analysis should be quite detailed in order to insure that no important aspect of the financial flow has been omitted, overlooked, or underestimated. But in the statement itself, as in any financial statement that we prepare, similar items should be judiciously combined and grouped, important aspects played up, and minor, inconsequential flows thrown into a "miscellaneous" or "all other" category. No one would disagree with the basic soundness of these commonsense rules of presentation of data. But a related problem lurks in the background on which there is no unanimity of opinion or of practice. The reference is to the extent to which similar sources and applications should be set off against each other. For example, all would agree that if X Company borrowed $1,000,000 from each of three different banks, we would meet all the niceties of disclosure and relevance if we reported a source of funds of $3,000,000 from bank borrowings; no one would insist that we ought to spell out the three separate borrowing operations. But suppose during the same period, X Company also paid off $1,500,000 of other bank loans. Should we now report a source of funds of $3,000,000 and an application

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[3] Wm. J. Vatter, "A Direct Method for the Preparation of Funds Statements," *Journal of Accountancy*, June 1946, pp. 479-89; also see "Correspondence" in the September 1946 issue of the same *Journal*, pp. 256-57.

of funds of \$1,500,000 or should we be content with the disclosure of a net source of funds of \$1,500,000 from bank borrowings?

Of more substance is the treatment of the funds flows generated by operations. Specifically, the reference is to the source of funds tapped by sales to customers and the applications of funds to wages, materials, etc. The reflection of a single source of funds from operations, calculated by adding nonfund charges to net profit, is found in most published analyses of changes in net working capital. But this practice may be omitting data on significant changes. Notice, for example, the difference in mode of treatment of the operating items in the American Phenolic data attached. In the statement of changes in working capital, funds provided by operations are shown conventionally in two figures: net profit for the year, and provision for depreciation. In the statement of cash receipts and disbursements, however, the influence of operating items is reflected in one item, sales, under receipts, and in four items under disbursements (specifically, materials, supplies and services; salaries and wages; taxes; and interest). The recommendation here being urged is to set forth a funds statement more along the lines of American Phenolic's "cash flow" than along the lines of the same company's working capital analysis. Fundamentally, the point being made is that we should guard against unwarranted inferences as to causal relationships, particularly when an application of funds is subtracted from an important source of funds, and the difference only then set forth in a formal statement.

Part of the difficulty here stems from the fiction that the funds statement is an attempt to explain what became of the profit, and that accordingly the tie-in must be with the net income figure. But even a casual examination of published funds statements will reveal that (a) they display sources and applications of funds beyond those connected with operations, and (b) they tie in with net working capital, or cash, or some other concept of funds, but not with net profit. No one can ever tell what became of net profit, a calculated magnitude, the difference between revenue and expense. We can tell a great deal however about the inflow of funds generated by sales, by borrowings, by issues of shares, and by other means, and the outflow of funds related to the services of employees, of suppliers, of lenders, of stockholders, etc. The influence of income-measurement is strong; it has obviously dictated the central position of the income statement. It has less obviously but nevertheless just as certainly dictated the form and content of the balance sheet. To judge by published statements, it has also influenced the form and content of the funds statement. But the proper function of a funds statement is not to tell us more about the income-generating and income-measuring processes, but rather to disclose data on the related but nevertheless distinct task of financial management of the enterprise.

EXHIBIT A

FINANCIAL CIRCULATION–A CLASSIFICATION

Funds are derived from
1. Contributions of stockholders;
2. Long-term loans, e.g., mortgages, bonds, equipment contracts;
3. Short-term loans supplied primarily by commercial banks;
4. Sales to customers. This class includes reduction of inventories;
4(a). Government subventions not included in (4), above, such as subsidies to airlines, steamship companies, etc.;
5. Disposal of non-current investments;
6. Disposal of plant, property, and equipment;
7. All other sources, e.g., gifts.

Funds are used to
1. Cover dividends and redeem shares of stock;
2. Services and retire long-term debt;
3. Service and pay short-term loans;
4. Cover operating costs, such as labor, materials, supplies, etc. This class includes increase of inventories;
4(a). Pay taxes not included in (4), above;
5. Acquire non-current investments;
6. Acquire plant, property, and equipment;
7. Cover all other applications, e.g., loss by embezzlement.

EXHIBIT B

X COMPANY FUNDS STATEMENT

For Period from ______ to ______

	Sources	Applications	
Funds, beginning of period			xxx,xxx
Fund changes during the period:			
I. Net funds from operations (profit or loss as adjusted for non-fund items)—See Note	xxxx		
II. Funds transactions with stockholders			
Dividends paid		xxxx	
Investments	xxxxx		
III. Funds transactions with long-term creditors			
Sale of bonds	xxxx		
Retirement of bonds		xxxxx	
IV. Funds transactions, involving plant and inventories, etc.			
Plant, intangibles, and investments		xxxx	
Decrease in inventories	xxxxx		
Totals	xxxxx	xxxxxx	
Net increase (decrease) in funds (See Schedule A) [Not reproduced]			xxx,xxx
Funds, end of period			xxx,xxx

Adapted from Hector Anton, *op. cit.*, p. 107.

NOTE: Anton concludes that, on balance, a reflection of net funds from operations fits in most closely with current practice and its apparent objectives. My own preference is for more detail, at least to the extent of revealing sales and the major operating costs. But in either case, the classification and form illustrated above will serve the purpose.

EXHIBIT C

AMERICAN PHENOLIC CORPORATION

Statement of Changes in Working Capital

	Year Ended December 31 1952	1951
Working Capital—Beginning of Period	$ 2,904,385	$ 3,845,476
Funds Provided—		
Net profit for year	$ 1,279,290	$ 941,868
Provision for depreciation	541,786	367,411
Proceeds from sale of fifteen year 4⅞% sinking fund notes	2,000,000	—
Sundry, net	201,879	50,971
Total funds provided	$ 4,022,955	$ 1,360,250
Funds Applied—		
Additions to plant and equipment	$ 1,050,481	$ 1,673,326
Provision for sinking fund including payment of long-term loans	969,049	232,950
Dividends declared	380,532	320,016
Increase in prepaid expenses	21,326	75,049
Total funds applied	$ 2,421,388	$ 2,301,341
Net increase or decrease in working capital	$ 1,601,567	$ 941,091
Working Capital—End of Period	$ 4,505,952	$ 2,904,385

AMERICAN PHENOLIC CORPORATION

Statement of Cash Receipts and Disbursements

	Year Ended December 31 1952	1951
Cash Balance—Beginning of Period	$ 1,295,109	$ 808,424
Receipts—		
Sale of merchandise to customers	$36,456,101	$24,355,836
Bank loans, including $3,200,000 "V" loan	—	3,950,000
Sale of U.S. Government securities	—	1,185,315
Refund of prior year's federal income taxes and renegotiation	—	45,261
Long-term 4⅞% loan	2,000,000	—
Sundry	101,575	110,941
Total receipts	$38,557,676	$29,647,353
Disbursements—		
Materials, supplies and services	$21,229,937	$19,106,502
Salaries and wages	8,312,128	6,572,904
Taxes, including purchase of U.S. Treasury tax savings notes	4,195,700	1,205,563
Plant and equipment	1,050,481	1,673,326
Dividends	360,408	320,000
Retirement of bank loans and "V" loans	1,450,000	—
Debentures purchased, including deposits with Trustee for retirement of long-term loans	978,825	170,411
Interest	254,733	103,962
Total disbursements	$37,832,212	$29,152,668
Net increase in cash balance	$ 725,464	$ 494,685
Cash Balance—End of Period	$ 2,020,573	$ 1,295,109

22. A WORKING MODEL OF THE FINANCIAL DYNAMICS OF A BUSINESS

Bernard Whitney and Marion S. Israel*

Experiments with reports and methods of assembling and presenting data are of considerable value in improving the understanding of often overlooked relationships and facts. The authors sketch the outline of an interesting model which combines facts of the balance sheet, operating statement, and application of funds.

The time-honored accounting statement depicts a frozen slice of an enterprise, cut at an instant of time, usually many transactions in the past. It would be very useful to have a model of the financial structure of a business, which would not only show the dynamics of what is occurring, but also indicate why it is happening. It is most important in planning ahead to recognize the interrelations or flow of funds within a business that support or detract from one another. Excluding those few people who have developed highly intuitive financial insight, it is difficult for most managers to derive sound analytical judgments concerning the financial dynamics of a business unit by examining the balance sheet and profit and loss statement. There are many figures on separate statements that must be correlated, and the sources of change are not apparent.

In this paper we do not propose to analyze whether traditional accounting statements portray the true financial picture. Nor is there need to elaborate on the time and labor required for the compilation of modern accounting statements. With few exceptions, businessmen consider them excessive, although many in the accounting field disagree. An extension of the method suggested here has made possible the successful solution of complicated accounting problems taken from CPA examinations in less than one-third the usual time.

Our analytical model for depicting the financial situation is a geometrical construction that combines three standard accounting presentations: the Balance Sheet, Operating Statement, and Application of Funds. These are combined to represent quantitatively: (a) what has occurred in the recent past, (b) the dynamics of the current situation, (c) present trends, and (d) the readjustments of assets and liabilities required to accomplish a given end. The model is intended to simplify the accounting

* From *Operations Research*, VI, 4 (1958), 573-79. Reprinted by permission of the authors and the Operations Research Society of America.

task and give management, after familiarization with its different form, a readily understandable and more complete concept of the financial interrelations within the business.

The illustration presented in this paper depicts on a single page information which would ordinarily require nine pages for the three-month period. The accounting formulations employed have been in use many years. The method is basically simple, but the development of the model

TABLE I
ABC ELECTRONICS COMPANY
Balance Sheet, March 31, 1957

ASSETS

Current assets			
Cash on hand	$ 1,000		
Cash in bank	105,000	$106,000	
Accounts receivable	$274,400		
Less provision for bad debts	12,400	262,000	
Inventories		97,000	
Total current assets			$465,000
Fixed assets			
Machinery and equipment	$304,650		
Less depreciation allowance	95,227	$209,423	
Furniture and fixtures	$141,954		
Less depreciation allowance	39,377	102,577	
Total fixed assets			312,000
Total assets			$777,000

LIABILITIES AND NET WORTH

Current liabilities			
Accounts payable		$ 97,162	
Accrued wages		2,348	
Taxes payable		1,490	
Loans and notes payable		6,000	
Total current liabilities			$107,000
Net worth			
Capital	$493,000		
Less drawings	—	$493,000	
Undistributed profit (loss) to date		177,000	
Total net worth			670,000
Total liabilities and net worth			$777,000

TABLE II
ABC ELECTRONICS COMPANY

Condensed Balance Sheets

	Jan. 1	Jan. 31	Feb. 28	Mar. 31
Cash in banks	$ 50,000	$ 76,000	$115,000	$106,000
Accounts receivable	42,000	106,000	68,000	262,000
Inventories	160,000	124,000	108,000	97,000
Total current assets	$252,000	$306,000	$291,000	$465,000
Fixed assets	270,000	260,000	322,000	312,000
Total assets	$522,000	$566,000	$613,000	$777,000
Accounts payable	$ 29,000	$ 31,000	$ 47,000	$107,000
Capital	493,000	493,000	493,000	493,000
Plus profit		42,000	73,000	177,000
		$535,000	$566,000	$670,000
Total liability and capital	$522,000	$566,000	$613,000	$777,000

Condensed Operating Statement

	January	February	March
Sales	$210,000	$174,000	$390,000
Material cost of sales			
Opening inventory	160,000	124,000	108,000
Add: purchases	35,000	38,000	112,000
Total	$195,000	$162,000	$220,000
Less: closing inventory	124,000	108,000	97,000
Material cost	$ 71,000	$ 54,000	$123,000
Gross operating profit	139,000	120,000	267,000
Depreciation	10,000	10,000	10,000
Other expenses	87,000	79,000	153,000
Total expenses	$ 97,000	$ 89,000	$163,000
Net profit	$ 42,000	$ 31,000	$104,000

into a practical device is the product of considerable effort. The new element which has been added is the juxtaposition of the old, familiar figures so that their interrelations are made clear.[1]

Table I shows a slightly modified version of the Balance Sheet of an existing company. Table II is the corresponding Profit and Loss Statement. With traditional accounting methods, each of these requires three pages, one for each month. Figure 1 presents a single conceptualization or model

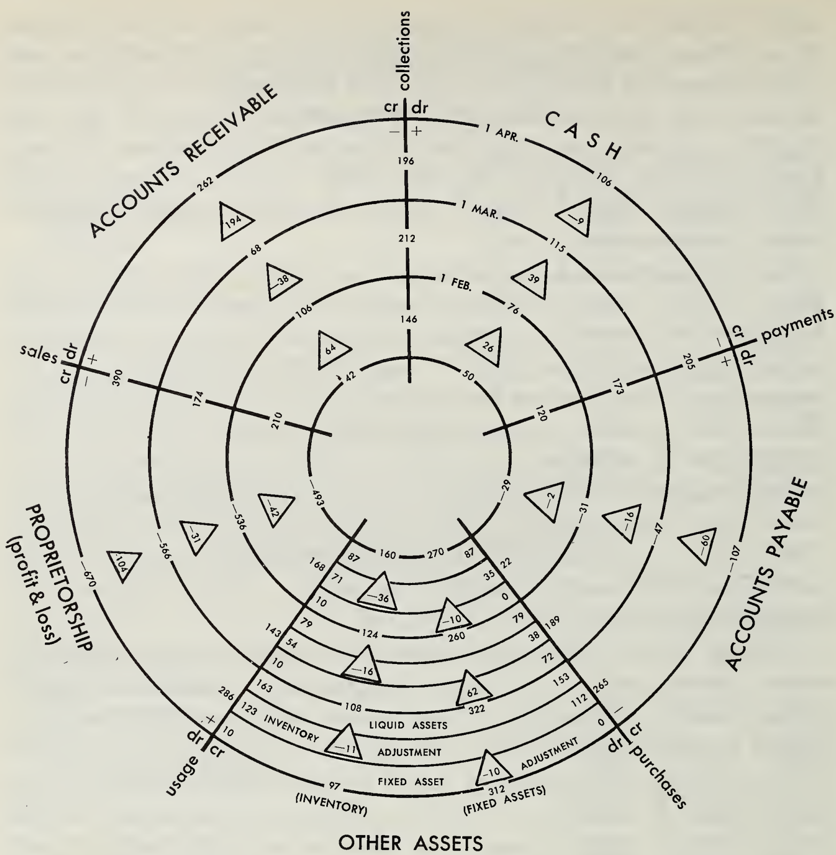
[1] In the development of this model, we have borrowed extensively from papers by Miss Helen Sunley.

which includes on one page not only the equivalent of the traditional Balance Sheet, Operating Statement, and Application of Funds, but additional information showing what has been occurring in the interrelations between these different viewpoints. The difference sectors of the circle together represent a complete financial picture of the business: Accounts Receivable, Cash, Accounts Payable, Other Assets, and Proprietorship. The concentric rings or annuli depict the data for three consecutive months in this example.

The "Payments" made by the business are in their proper relation when placed on the radial line which separates Cash and Accounts Payable. Similarly, "Purchases" are correctly located on the radius between Accounts Payable and Other Assets, "Usage" between Other Assets and Proprietorship, "Sales" between Proprietorship and Accounts Receivable, and "Collections" between Accounts Receivable and Cash. The logic of this arrangement is confirmed if we adopt the following method of showing the beginning and ending balances for each month and the differences between them: the balances in each account are shown on the appropriate "date circle," in the center of the appropriate sector. Thus, for example, the balance in Accounts Receivable on January 1 was 42 ($42,000). On February 1, it was 106, and on March 1, 68.

Looking outward from the center of the model, on the lefthand or counterclockwise side of each sector representing a particular account in a given month is the addition to that account which occurred during that month. In the case of Accounts Payable for January, the addition was 120. At the right side of this same sector is shown the total deduction from the account, in January, 122. The net difference or increment between this income and outgo is minus 2, as shown in the delta (triangle) in the center of this circular segment. Since the balance of Accounts Payable at the end of January is the beginning balance for February, it is shown as minus 31 located appropriately on the concentric circle marked Feb. 1 representing the transition of January to February. This quantity, minus 31, is the negative increment of income-outgo (minus 2, referred to above) added to the January 1 Accounts Payable balance, shown as minus 29.

As the circle is "rotated" or examined from different viewpoints along its periphery, we see that the additions to Accounts Payable along the Payments radial (120, 173, 205) are also the Cash outgo (at the right or clockwise side of the Cash sector). The collections, which as additions to the Cash account are shown at the left of this sector along the Collections radial (146, 212, 196), are in turn the outgo for Accounts Receivable. Similarly, Sales, which are income for Accounts Receivable, are also the outgo for Proprietorship.



Balance sheet, operating statement, and application of funds, first quarter, January 1 — March 31 (thousands of dollars).

FIGURE 1

In the Other Assets segment of Fig. 1, a further breakdown is exemplified. The segment of the concentric circle representing this account for March has been subdivided into three parts: an outer portion for "fixed asset adjustment," one for "inventory adjustment," and another for very "liquid assets." The same conventions are maintained with income to the left facing outward from the center of the model, outgo to the right, and the increment or difference in the delta triangle between.

Because the quantities it portrays are derived from accounting statements that must balance and because of its construction, there are certain sequences within the model that must balance out or total correctly. The quantities on any full circle must total zero algebraically (equivalent to

the zero difference or balance between Other Assets, and Liabilities and Proprietorship, on the standard accounting Balance Sheet). Thus, for example, on February 1: +76, +106, −535, +384, and −31 = 0. The sum of the quantities in the deltas located within the same concentric circle must also add agebraically to zero (equivalent to Profit and Loss). Examining the figures for the month of February in Fig. 1, we find (beginning with Cash): +39, −38, −31, +46, −16 = 0. Likewise, within any sector (Cash, for example), the beginning balance for any month (inner circle) must add to its delta to give the closing balance (outer circle). For February: +76, +39 = +115. And finally, the income and outgo within any one annulus must balance with the incremental difference shown in the delta. In Proprietorship for the month of March: −390 (outgo or credit) +286 (income or debit) = −104 (delta).

These balancing sequences provide easy and automatic checks for the manager who is not thoroughly familiar with the traditional accounting statements expressed separately and usually on different sheets. Equally important, the form of the model emphasizes the necessary interrelations not only between the quantities themselves, but what they represent concerning the financial operations of the business.

For example, the model shows clearly that: profit = (increase in assets) + (decrease in liabilities). In March, for example, the profit of 104 ($104,000) is composed of: Accounts Receivable, +194; Cash, −9; Accounts Payable, −60; Other Assets, −21 (inventory adjustment, −11; fixed asset adjustment or depreciation, −10; and 0 change in liquid assets). The March profit of 104 is also readily seen to represent the difference between Sales of 390 and Usage of 286.

This form of analytical report can be prepared in a few hours from the usual accounting journals or from a specially designed summary journal. This eliminates waiting for the posting of the general ledger and speeds up crucial financial information by days or even weeks. The model is easily revised weekly, daily, or irregularly when needed, in contrast to the inflexible monthly schedule normally required for all practical purposes by traditional accounting methods.

The model is also useful for planning purposes. Referring again to Fig. 1 the executive can project the situation for the forthcoming month (in this case, April) in accordance with certain assumptions he wishes to make. Let us suppose he would like to double Sales again. From previous experience, he can estimate quite closely what his Accounts Payable and Accounts Receivable will be at this assumed Sales volume. Likewise, he can project probable Collections and Usage. With these data, Cash requirements are calculated readily and he may discover these are beyond his present means. Failure to recognize the cash requirements of expanded operations is in fact a common error in planning frequently made

by smaller enterprises. Various ratios, limits for accounts payable, and purchase requirements can be determined in the same way.

In performing this projection into the future, the executive is required by the form of the model to identify and make certain estimates, to combine his assumptions and calculations based on empirical ratios in their proper interrelation so that they balance, and he cannot omit any one of the necessary financial components. Once he is familiar with these interrelations, he may prefer that the circular model be 'unrolled' and presented in tabular form.

The concept of differentials expressed by the quantities within the deltas in the model can be incorporated into the regular accounting system by recording a "third entry" of the differentials reflecting the changes between past and current balances in the accounting ledger. Companies which have adopted this method of differential accounting obtain financial reports that depict the flow of goods and money through the enterprise and show the causation of changes in assets, liabilities, working capital, and profit components. An accounting matrix composed of all the elements of the financial process is used to develop optimum strategies, by varying anticipated changes in sales volume, costs, collections, or other components subject to manipulation by management.

VI

INVENTORY AND THE ADMINISTRATOR

23. STREAMLINED INVENTORY CONTROL AND STABILIZED PRODUCTION PLANNING

Herbert J. Richmond*

Mr. Herbert J. Richmond lists and discusses various factors and considerations which are important in establishing inventory and related production policies. One of the important points is the analysis and control of inventory components on a value basis.

Many business systems and policies which are sufficient for current conditions may prove inadequate in the future because of the increased pressures for automation and the guaranteed annual wage. The constant drive for lower sales prices and enlarged productive facilities will also put a strain on those systems and policies which now seem satisfactory.

Are your company's policies and procedures for inventory control and production planning established to meet future requirements and to give maximum profits, stabilized production and good relations with customers, vendors and employes?

What steps are being taken to insure that men and machines will be serviced on a continuous basis with a consistent supply of parts and materials and with a minimum of paperwork?

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* From *The Controller*, XXIV, 4 (1956), 162-64, 182, 184-85, 196. Reprinted by permission of *The Controller*.

Programs which will give affirmative answers to these questions may vary from company to company, depending upon the industry and the organization's policies, procedures and finances, but there are general points relating to inventory planning which can be considered in appraising these matters.

1—ANALYSIS AND CONTROL BY VALUE

It is extremely important that the individual elements of the inventory be carefully analyzed since control and planning begin with the individual part and material. Each item in the inventory has its own characteristics which will determine its control. The annual usage of the item is extended by its unit cost to determine the annual expenditure for that part. The value basis is the best guide for classifying parts and for applying the degree of control necessary to recognize the dollar importance and to minimize inventory investment and the costs of control, such as paperwork, set-up, material handling, costing and issuance.

In many companies the same policies, procedures and paperwork are applied to an item whose total yearly usage is $80 as is given to an item whose total annual usage is $80,000. This is true despite the fact that the numbers of items of high value in any inventory usually represent a small proportion of the total items, although their dollar proportion of the total inventory is large.

Until such time as a value analysis is made and the valuable dollar elements of the inventory are isolated, there is no firm basis for the controlling of inventories and the planning of production. The task is not easy and requires trained personnel with established objectives to accomplish the segregation and identification of items. Once this project has been accomplished the benefits are immediate because policies can be established for handling the small number of valuable parts and the large number of low-value parts.

This approach gets to the root of the excessive paperwork and immediately eliminates a sizable volume of transactions. This saves on clerical costs, machine rentals and indirect shop labor. It directs the attention of all the organization to the valuable elements which should be most intensely studied and what action should be taken to improve control, ordering, receipt, and to effect cost reductions through improvements in design, methods, tooling and competitive prices from vendors. It shows the need for condensing and standardizing of material, parts and products because of the high number of items which are low value because of low usage.

This analysis has been made by some companies. It is known as the "A-B-C" or proportional parts analysis system. Its interesting implications can be seen from actual company experiences where it has been found

that 10% of the inventory items account for approximately 75% of the dollar value. If this percentage is expanded to 25% of the items, it will usually cover 95% of the value, leaving 75% of the items accounting for only 5% of the total dollar inventory. Its principle is based on control by exception with clearly established policies and procedures which recognize the difference in objectives.

2—INVENTORY POLICIES BASED ON VALUE ANALYSIS

Different inventory policies are required for the valuable items of the inventory and for the other items. It may be necessary to have daily, weekly or monthly review of the valuable items and to reduce their investment through continuous scheduling of receipts. The fixed costs of order-writing, follow-up, set-up, material handling and record keeping are a small proportion of the total cost of the item because of the high usage and high value criterion. Changes in sales forecasts or trends will be quickly reflected in increases or decreases in the quantities ordered and the scheduling of receipts. The most qualified personnel should be selected to control these items.

The effects on the factors of obsolescence and carrying costs are decreased because they are based on a time element which is shorter in the case of these valuable parts. This is usually not considered in the various formulas for determining the ordering quantities for parts since they are based on a straight-line computation for obsolescence and carrying charges.

One of the difficulties encountered in management policies relating to close inventory control is the interpretation placed on such directives by the personnel responsible for their execution. When management desires an inventory reduction it wants dollars cut out of the inventory but does not want indirect labor, direct labor, or handling and set-up costs to be materially increased. The actual results of many inventory directives are that ordering quantities are reduced for both "A" and "B-C" items. The intent was to provide for increased control on the valuable items "A," in the inventory where the dollar inventory reductions can be achieved.

By increasing the frequency of order issuance for all items a flood of orders is created by the purchasing and production planning personnel. This quickly results in high costs of set-up, paperwork, material handling, tool and die maintenance and handling, poor relationships with vendors and lack of parts to meet production schedules. It leads into excessive expediting, breaking into machines, and hurry-up calls to purchasing (and manufacturing) to get additional parts or material. The costs of storeroom operations go up since the frequency of handling and the amount of storage space is increased.

The keystone to inventory policy is determining of the proper ordering quantity. Some general guides can be laid down. These are illustrative and would vary with the industry, the type of product, and the labor and material contents of the piece.

1. High-Value Items ("A" 10% of items)—These would be ordered a maximum of six times a year and a minimum of three times, with a dollar limit of $300.00 per order.
2. Middle-Value Items ("B" 15% of items)—These would be ordered a maximum of three times a year and a minimum of two times a year, with a dollar limit of $150.00.
3. Low-Value Items ("C" 75% of items)—These would be ordered a maximum of two times a year and a minimum of once a year, with a dollar limit of $80.00.

From the above example, it can be seen that more months of supply can be purchased or manufactured within the dollar limits of the low-value item, and that the frequency of ordering is deliberately made greater in the high-value item. These various points can be covered in the respective inventory policies for the different classes of parts and will be easily understood by the people working with these instructions. Exceptions to the policy will occur because of a special situation for an item, but such deviations are approved by a responsible, major supervisor having the necessary judgment.

3—LEAD TIMES

Policies for lead times of high-value and low-value items can be used to gain cost and delivery advantages and to provide production flexibility for each class of stock parts and parts made to customer order which require the shortest possible cycle.

Since the objective is for quick turnover and quick production of the valuable items, their lead time can be 15 to 30 days less than the lead time for the other stock items. The lead time for the special parts made to customer order could be 15 days less than the valuable items. This establishes a priority of work which can easily be explained to shop supervision and also to the purchasing personnel.

This recognizes that the low-value items are the most costly to produce in terms of their fixed cost, paperwork, handling and set-ups and it is important to achieve economies wherever possible. Through the use of longer lead times for this class of item, the factors can use these items for fill-in work, for work planning and for utilization of material. The longer lead time permits this planning and grouping for savings in set-up and material without interference with the valuable items and the customer orders.

The attention of the organization is given to the high-value items to see that they are manufactured and purchased without any delay in either the paperwork, the procurement or the receiving of these items, and that the inventory investment is minimized.

In accomplishing this objective, the organization can study the high-value items for possible short cuts in production methods or purchasing techniques. Any savings in lead time on these items has a marked effect on costs and on inventory investment.

Provision is made for the quickest possible purchasing or manufacturing of special nonstock parts ahead of all stock parts.

4—MANPOWER, MACHINE AND MATERIAL PLANNING

The segregation of the items into the high-value class helps the forecasting of requirements for manpower, machines and material. These elements can be projected for the relatively few number of valuable items and then a factor added to cover the rest of the items. This gives a good yardstick for personnel, machines and material requirements.

Many attempts to quickly and currently provide such information have been defeated by including all items without the identification of the valuable elements of the inventory. The sheer volume of work involved caused the effort to fail and rendered any figures meaningless.

5—PROTECTIVE STOCK

The determination of an adequate protective balance to be carried for each stock item is essential. This quantity is insurance against stock depletion due to late deliveries from suppliers or from the factory and for unusual sales which exceed the projected average pattern on which the ordering quantity is based.

The careful provision for such stock minimizes rush orders having to be placed to build up the supply. It prevents shortages developing which interfere with shipments or with assembly production. The breaking into production or into purchasing for these rush orders causes considerable lost time, expediting and other expensive operations. The performance, efficiency and production of the assembly department are seriously hampered. Excessive costs and customer complaints are incurred in corresponding with customers relative to failure to deliver on schedule. Often the low-value items requiring a minimum of dollar investment are the ones which are out of stock and are delaying shipment and limiting inventory turnover.

This protective stock can also be used to provide for uninterrupted service in the event of strikes, especially in the case of difficult-to-procure

material and in vital raw materials which are basic to the production of the company.

Cash carefully invested in this reserve will yield a major return.

General rules can be established for the protective stock by class of part. A protective stock for valuable items might be one-half a month's projected average sales and for other items two months' projected average sales. Further refinements can be determined for the individual part by analyzing each part to show its average delivery times, average sales, and the deviation from the average sale. This deviation can be established as the protective stock. This will provide coverage for this quantity and can result in less inventory.

The analysis can be done on the valuable items. On the others it would not be necessary to do such an analysis, both because of limited inventory investment and because of the wide fluctuations which usually occur in these parts.

6—INVENTORY INVESTMENT FOR PRODUCTION STABILIZER

In many situations a careful examination will show that it is advantageous to carry inventory for a period of time in order to use the slow sales period to produce parts, subassemblies or final units. This will depend on the situation involved.

It is possible to minimize this type of investment and the required storage space by keeping the part and subassemblies in stock and increase the production on the assembly lines by adding men through transfer from parts departments or by part-time help. This avoids tying up assembly labor in the inventory.

Another approach is to assemble all manufactured parts but leave out the critical purchased items, such as an expensive motor or an expensive exhaust installation. There are many ways of approaching this problem which can be adopted by the individual company to meet its needs.

The planned production of such inventory by trained workers avoids the costs of training new personnel, the attendant risk of poor quality and of tool and die breakage, and the unfavorable element of having parts subcontracted thus perhaps inviting competition into your business. Further savings are realized through reducing overtime payments and higher production because of normal working hours.

It is important that the working force be kept flexible and trained to perform various jobs in order that the changing load picture can be met without interruption and delay, or without adding to the work force.

The inception of such a program designed to train a diversified labor pool is expensive and requires a good training program under the direction of capable company personnel.

The program helps in covering vacation periods and leads to the discovery of capabilities in personnel previously not observed. It gives added interest and stimulation to company personnel since it relieves the monotony of one job and one operation.

The effect on personnel relations is good because it provides steady work, avoids high costs and unsatisfactory production resulting from the bumping of employes from job to job to adjust to the new work force and the company seniority. This factor alone is an inducement to carefully planning for an even flow of production and an increased inventory investment for a limited period of time.

Having an adequate and planned inventory before the seasonal upsurge permits the company to take unusual orders in the busy season without undue difficulties and extension of work hours or of work force.

Many companies are finding that it is sound business to borrow money for inventories built for this purpose. The costs and penalties of intermittent production represent a very high operating charge. Any decision regarding major inventory investment is a responsibility of top management. Such a policy should be fully developed, formalized, communicated to its administrators, and be carefully checked at regular intervals. This program should have dollar limits for the various inventory levels which will reflect the program authorized by management.

7—SEPARATE PROGRAMS FOR PARTS MANUFACTURING AND FOR ASSEMBLY

Separate policies for the manufacturing of parts, the purchasing of parts and the assembling of purchased and manufactured parts into sub- or final assemblies will provide flexibility of operations, will limit inventory investment, and will enable the production load to be treated in its basic elements.

Each manufactured part has its own characteristics and will be ordered accordingly. A plan can be developed for carrying out this objective by having the "A" parts ordered in greater quantities during the seasonal lull, which automatically increases the reserve stock available to meet the seasonal peaks which are reflected in the increased assembly schedule. A review can also be made of "B" and "C" parts and orders placed for those items which are approaching their reorder point. This saves machine time in the busy season and helps delivery to customers.

A separate policy is required for purchased parts since there is usually no advantage to having them received ahead of the time when they are required for final assemblies. The purchasing department can carefully analyze and schedule the receipts of such parts with the vendors on such a basis as to have the vendor protected for the necessary inventory of raw materials which might be required for the final purchased parts. This keeps

the inventory investment at a minimum and yet affords protection to the vendor in order to guarantee a smooth flow of purchased parts in the busy season. Many vendors are willing to carry a stock of finished parts built ahead in order that they may level their productions. The vendor retains title to the parts and is protected since he knows the anticipated usage schedules of the customer.

The policy for the control of subassemblies and final assemblies should be carefully developed because of their effect on inventory investment, the flexibility of parts, and the storage problems created. Generally speaking, it is easier to increase the production tempo of assembly lines than the production of parts. Under modern production methods the number of stations on the line can be increased and additional subassembly lines can be created to feed into the main assembly line.

A careful review should be made of the production drawings and production practices relating to stocked subassemblies. It is important that they be kept to a minimum. Properly controlled, they can be used for building up stock ahead of the assembly line if the consideration of storage and value meets the tests of such practice. In many situations it is better to treat them as sublines which are started earlier than the main assembly lines and are feeder lines. In this situation a bank of such line assemblies is created ahead of the main line.

Good policies and practices relative to stocked subassemblies, line subassemblies and final assemblies are the result of close and careful considerations on the part of the engineering, industrial engineering, production planning and production supervisory personnel, all having a clearly defined objective upon which to base their composite decision. All their knowledge is required to develop and reduce to practice sound policies for the control of assemblies.

8—RELATIONS WITH VENDORS

A smooth flow of production is difficult to obtain without good relationships with vendors. Policies should be developed which will interest good vendors in establishing—and maintaining with the customer—records of reliability of delivery, good quality of merchandise, and a fair price structure. In return, they should expect reasonable requests for deliveries with consideration given to good ordering quantities. Suppliers do not expect to have purchasing orders placed for a year's supply of the valuable items. On the other hand, they do expect and encourage ordering of low-value parts on as infrequent a basis as possible.

They will appreciate being furnished projection of anticipated requirements with progressive segments of the projection being firmed up as commitments. This enables them to make their own company plans on a better basis. In many situations they are willing to carry some stock if it

can be proven that they will have steady and profitable relationships with the customer.

Any of the above advantages can be achieved by carefully developed production programs and by interchange of information between the vendor and the customer. In many situations the vendor can make suggestions as to improvement in design specifications, which will permit price reduction by the vendor without sacrifice in product acceptability. This calls for close relationship between the engineering, manufacturing, and purchasing personnel and the vendor.

The records of the purchasing department should be established to quickly reveal unreliable vendors whose quality, price or deliveries are unsatisfactory. Such records should be used to correct the situation by satisfactory performance or by the changing of vendors.

A company policy can be developed which provides for at least two vendors as sources. This provides protection against interruption in the supply and also develops competition between the vendors. Such a policy should be explained to the vendors and requires the engineering specifications being written to permit such practice.

9—GOOD STOREROOM OPERATIONS

Programs designed for a steady flow of production require good storerooms and good storeroom procedures. Policies should be developed for having well-protected and controlled storage areas, for the storing of parts having similar characteristics in similar storage equipment, for the receipt and issue of parts using the proper transaction paper, and for daily operations being kept current for receipts and issues.

Characteristics of parts as to storage and issue should be studied. Provision should be made for simplifying the handling of receipts and issues, giving consideration to simplification of paper transactions on inventory and production records. This can result in substantial improvements and savings in clerical and storeroom costs. The time required for the taking of inventories can be considerably shortened through techniques of storage, stores control, and inventory and production records.

Examples of practices which result in over-all savings are the issuing of working supplies of hardware to assembly lines, the bundling, tagging and issuing of parts in bulk lots, the designing of racks and handling equipment for special classes of items, and the purchasing of packaged lots from vendors which fit the production requirements of the company.

Working hours in the storerooms can be established to provide a steady flow of parts to assembly floors while, at the same time, making sure that receipts of parts from the manufacturing and purchasing departments are being promptly counted, reported and placed in their permanent locations.

Interruptions in regular work can be minimized by having regular hours of issues with the cooperation of the production supervisors.

Provision for adequate storage and personnel is very important to the whole program of production flow. As much consideration should be given to the adequacy of storage space, equipment and personnel as is given to manufacturing space and personnel. Inadequate storage space will result in manufacturing space being used for storage, and also in unsatisfactory control of stores property with the attendant delays in production.

10—PLANNING FOR CHANGES TO MODELS OR PARTS

Policies relating to the changing of models or parts and their timing have a major effect on deliveries, costs and manpower, machine and material utilization. It is reasonable to assume that this major phase will receive increased attention in the future. So many different phases of the business are affected that improperly timed changes cause strains on the entire organization.

Policies in this field should provide for long-range thinking on product development, for the detailed scheduling of such projects so that they are placed in production in off-season times, that changes to parts be carefully studied in relation to value of the part ("A" parts should receive major attention), and that careful consideration be given to existing tooling, stock on hand, and effect on service as to interchangeability.

Any decisions involving changes to parts or products should be promptly conveyed to the personnel responsible for production and inventory. This permits them to take immediate steps to prevent the accumulation of stock for parts which are to be obsoleted and allows them time to obtain new material, tooling and other items required for the proposed change.

As the development proceeds, provisions should be made for seeing that inventory policies are carried out in the creation of assemblies, subassemblies and parts which follow inventory and production practices. The production drawings for assemblies and parts should reflect such policies since they are the source required to make these policies effective. This requires a thorough understanding on the part of the engineering, industrial engineering, production planning and production supervision as to the over-all policies of the company related to inventory and production philosophy. The reduction of the product development to the production design affords the opportunity to carry out such policies.

Proper scheduling of work will permit the engineering personnel being given an opportunity to level their work load through working on development, design and engineering change in periods not involved on heavy work for customer application.

11—SALES FORECASTING

Careful and accurate planning of inventories and production is based on reliable sales forecasts. The expected trends of business are guideposts to point the way to decisions for short- and long-range programs.

The minimum amount of forecasting which is necessary is an annual forecast which is firmed up on a quarterly basis. The quarterly figures are used for commitments and manufacturing schedules. The annual forecast affects the annual ordering quantities, the expected commitments with vendors, and the manpower and machines required to meet the anticipated volume.

It is usually helpful if the quarterly trend is a continuous three months' projection because action can be taken to provide for the trend indicated in the newly added month.

The annual forecasts should be prepared early enough to avoid having a gap in the long-term trends when the end of the current annual forecast is approached.

These sales forecasts cannot be detailed to show the expected usage of the individual parts or subassemblies. These are controlled on the basis of the over-all indicated trend which, in turn, is reflected in the projected average monthly usage. This is used to determine the ordering and control of the individual part. Usually the lead time of the part is sufficiently short as to enable changes in usage trends being reflected in the ordering of the part when it reaches its reviewing and ordering point.

The valuable items ("A") should be closely checked for changes in projected average monthly usage and full attention be given to those parts. Outstanding purchase or production orders should be adjusted to meet indicated changes in usage. This adjusts supply to the expected demand and keeps the dollar inventory in the optimum balance. Conversely, the less valuable items ("B" and "C") have little effect on the inventory dollars and changes in trends can be covered when the reviewing and ordering point is reached. Under this concept the degree of attention and changes in order quantities and delivery date corresponds with the degree of value and investment.

12—RELATIONS WITH CUSTOMERS

One of the greatest assets in any business is its relationships with its customers. A good part of this asset depends on the ability to make shipment on schedule, at a fair price and with good quality merchandise.

The customers require quicker delivery when the supply situation is adequate because they will usually prefer having the company act as their warehouse and avoid cash outlay for inventory not currently being used. These factors are increasingly apparent in the present situation and the

only difference is the degree between various industries. Even though a specific industry at the moment is in a tight supply situation, there is no guarantee that that will continue forever. Accordingly, it is important that management prepare for that day by maintaining balanced, strategically located stocks of inventory available for quick shipment. The company which achieves these objectives has a distinct competitive advantage over others not so forward thinking.

A concerted program will be required on the part of general, sales, financial, purchasing and manufacturing management since all will participate in achieving the vital objective of customer goodwill and the addition of new customers who are attracted by progressive inventory management and reliability of source along with factors of price and quality. Special attention should be given to the allocation of stock to incoming orders from customers to avoid temporarily being out of stock because of filling a very large order when a partial shipment might have been made which would leave enough stock for the other customers. The decision and control of finished stock should generally be assigned to the merchandising group, since they are most familiar with their customers and their requirements. Some organizations have set up inventory controllers within the merchandising group for this purpose, as well as tying in with general management policies on inventory levels.

One of the major tests of a good inventory control and production planning system is its ability to meet customer requirements based on good sales forecasting and good procurement and manufacturing practices. Usually a company having a high degree of reliability in meeting shipping promises will also have high profits within the industry.

24. GUIDES TO INVENTORY POLICY I. FUNCTIONS AND LOT SIZES

John F. Magee*

Mr. John F. Magee examines the functions of an inventory and discusses the conflicting attitudes influencing the size and structure of the inventory. Among the problems discussed is the difficulty of finding the proper costs to assign to the maintenance of an inventory as well as other matters to be taken into account in establishing a proper policy. An illustration of a hypothetical inventory situation is used to tie together the main points covered in the first of a three article series.

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"Why are we always out of stock?" So goes the complaint of great numbers of businessmen faced with the dilemmas and frustrations of attempting simultaneously to maintain stable production operations, provide customers with adequate service, and keep investment in stocks and equipment at reasonable levels.

But this is only one of the characteristic problems business managers face in dealing with production planning, scheduling, keeping inventories in hand, and expediting. Other questions—just as perplexing and baffling when managers approach them on the basis of intuition and pencil work alone—are: How often should we reorder, or how should we adjust production, when sales are uncertain? What capacity levels should we set for job-shop operations? How do we plan production and procurement for seasonal sales? And so on, and so on.

In this series of articles, I will describe some of the technical developments which aim at giving the business manager better control over inventory and scheduling policy. While these techniques sometimes employ concepts and language foreign to the line executive, they are far from being either academic exercises or mere clerical devices. They are designed to help the business manager make better policy decisions and get his people to follow policy more closely.

In the present article major attention will be devoted to (a) the conceptual framework of the analytic approach, including the definition of inventory function and the measurement of operational costs; and (b) the problem of optimum lot size, with a detailed case illustration showing how the techniques are applied.

This case reveals that the appropriate order quantity and the average inventory maintained do not vary directly with sales, and that a good answer to the lot size question can be obtained with fairly crude cost data, provided that a sound analytical approach is used. The case also shows that the businessman does not need calculus to solve many inventory problems (although use has to be made of it when certain complications arise).

INVENTORY PROBLEMS

The question before management is: How big should inventories be? The answer to this is obvious—they should be just big enough. But what is big enough?

This question is made more difficult by the fact that generally each individual within a management group tends to answer the question from his own point of view. He fails to recognize costs outside his usual framework. He tends to think of inventories in isolation from other operations. The sales manager commonly says that the company must never make a

customer wait; the production manager says there must be long manufacturing runs for lower costs and steady employment; the treasurer says that large inventories are draining off cash which could be used to make a profit.

Such a situation occurs all the time. The task of all production planning, scheduling, or control functions, in fact, is typically to balance conflicting objectives such as those of minimum purchase or production cost, minimum inventory investment, minimum storage and distribution cost, and maximum service to customers.

INVENTORY FUNCTIONS

Fundamentally, inventories serve to uncouple successive operations in the process of making a product and getting it to consumers. For example, inventories make it possible to process a product at a distance from customers or from raw material supplies, or to do two operations at a distance from one another (perhaps only across the plant). Inventories make it unnecessary to gear production directly to consumption or, alternatively, to force consumption to adapt to the necessities of production. In these and similar ways, inventories free one stage in the production-distribution process from the next, permitting each to operate more economically.

The essential question is: At what point does the uncoupling function of inventory stop earning enough advantage to justify the investment required? To arrive at a satisfactory answer we must first distinguish between (a) inventories necessary because it takes time to complete an operation and to move the product from one stage to another; and (b) inventories employed for organizational reasons, i.e., to let one unit schedule its operations more or less independently of another.

MOVEMENT INVENTORIES

Inventory balances needed because of the time required to move stocks from one place to another are often not recognized, or are confused with inventories resulting from other needs—e.g., economical shipping quantities (to be discussed in a later section).

The average amount of movement inventory can be determined from the mathematical expression $I = S \times T$ in which S represents the average sales rate, T the transit time from one stage to the next, and I the movement inventory needed. For example, if it takes two weeks to move materials from the plant to a warehouse, and the warehouse sells 100 units per week, the average inventory in movement is 100 units per week times 2 weeks, or 200 units. From a different point of view, when a unit is manufactured and ready for use at the plant, it must sit idle for two weeks while

being moved to the next station (the warehouse); so, on the average, stocks equal to two weeks' sales will be in movement.

Movement inventories are usually thought of in connection with movement between distant points—plant to warehouse. However, any plant may contain substantial stocks in movement from one operation to another—for example, the product moving along an assembly line. Movement stock is one component of the "float" or in-process inventory in a manufacturing operation.

The amount of movement stock changes only when sales or the time in transit is changed. Time in transit is largely a result of method of transportation, although improvements in loading or dispatching practices may cut transit time by eliminating unnecessary delays. Other somewhat more subtle influences of time in transit on total inventories will be described in connection with safety stocks.

ORGANIZATION INVENTORIES

Management's most difficult problems are with the inventories that "buy" organization in the sense that the more of them management carries between stages in the manufacturing-distribution process, the less coordination is required to keep the process running smoothly. Contrariwise, if inventories are already being used efficiently, they can be cut only at the expense of greater organization effort—e.g., greater scheduling effort to keep successive stages in balance, and greater expediting effort to work out of the difficulties which unforeseen disruptions at one point or another may cause in the whole process.

Despite superficial differences among businesses in the nature and characteristics of the organization inventory they maintain, the following three functions are basic:

1. *Lot size inventories* are probably the most common in business. They are maintained wherever the user makes or purchases material in larger lots than are needed for his immediate purposes. For example, it is common practice to buy raw materials in relatively large quantities to order to obtain quantity price discounts, keep shipping costs in balance, and hold down clerical costs connected with making out requisitions, checking receipts, and handling accounts payable. Similar reasons lead to long production runs on equipment calling for expensive setup, or to sizable replenishment orders placed on factories by field warehouses.

2. *Fluctuation stocks,* also very common in business, are held to cushion the shocks arising basically from unpredictable fluctuations in consumer demand. For example, warehouses and retail outlets maintain stocks to be able to supply consumers on demand, even when the rate of consumer demand may show quite irregular and unpredictable fluctuations. In turn, factories maintain stocks to be in a position to replenish retail and field warehouse stocks in line with customer demands.

Short-term fluctuations in the mix of orders on a plant often make it necessary to carry stocks of parts of subassemblies, in order to give assembly operations flexibility in meeting orders as they arise while freeing earlier operations (e.g., machining) from the need to make momentary adjustments in schedules to meet assembly requirements. Fluctuation stocks may also be carried in semifinished form in order to balance out the load among manufacturing departments when orders received during the current day, week, or month may put a load on individual departments which is out of balance with long-run requirements.

In most cases, anticipating all fluctuations is uneconomical, if not impossible. But a business cannot get along without some fluctuation stocks unless it is willing and able always to make its customers wait until the material needed can be purchased conveniently or until their orders can be scheduled into production conveniently. Fluctuation stocks are part of the price we pay for our general business philosophy of serving the consumers' wants (and whims!) rather than having them take what they can get.

3. *Anticipation stocks* are needed where goods or materials are consumed on a predictable but changing pattern through the year, and where it is desirable to absorb some of these changes by building and depleting inventories rather than by changing production rates with attendant fluctuations in employment and additional capital capacity requirements. For example, inventories may be built up in anticipation of a special sale or to fill needs during a plant shutdown.

The need for seasonal stocks may also arise where materials (e.g., agricultural products) are *produced* at seasonally fluctuating rates but where consumption is reasonably uniform; here the problems connected with producing and storing tomato catsup are a prime example.

STRIKING A BALANCE

The joker is that the gains which these organization inventories achieve in the way of less need for coordination and planning, less clerical effort to handle orders, and greater economies in manufacturing and shipping are not in direct proportion to the size of inventory. Even if the additional stocks are kept well balanced and properly located, the gains become smaller, while at the same time the warehouse, obsolescence, and capital costs associated with maintaining inventories rise in proportion to, or perhaps even at a faster rate than, the inventories themselves. To illustrate:

Suppose a plant needs 2,000 units of a specially machined part in a year. If these are made in runs of 100 units each, then 20 runs with attendant setup costs will be required each year.

If the production quantity were increased from 100 to 200 units, only 10 runs would be required—a 50% reduction in setup costs, but a 100% increase in the size of a run and in the resulting inventory balance carried.

If the runs were further increased in length to 400 units each, only 5 production runs during the year would be required—only 25% more reduction in setup costs, but 200% more increase in run length and inventory balances.

The basic problem of inventory policy connected with the three types of inventories which "buy" organization is to strike a balance between

the increasing costs and the declining return earned from additional stocks. It is because striking this balance is easier to say than to do, and because it is a problem that defies solution through an intuitive understanding alone, that the new analytical concepts are necessary.

INVENTORY COSTS

This brings us face to face with the question of the costs that influence inventory policy, and the fact, noted earlier, that they are characteristically not those recorded, at least not in directly available form, in the usual industrial accounting system. Accounting costs are derived under principles developed over many years and strongly influenced by tradition. The specific methods and degree of skill and refinement may be better in particular companies, but in all of them the basic objective of accounting procedures is to provide a fair, consistent, and conservative valuation of assets and a picture of the flow of values in the business.

In contrast to the principles and search for consistency underlying accounting costs, the definition of costs for production and inventory control will vary from time to time—even in the same company—according to the circumstances and the length of the period being planned for. The following criteria apply:

1. *The costs shall represent "out-of-pocket" expenditures, i.e., cash actually paid out or opportunities for profit foregone.* Overtime premium payments are out-of-pocket; depreciation on equipment on hand is not. To the extent that storage space is available and cannot be used for other productive purposes, no out-of-pocket cost of space is incurred; but to the extent that storage space is rented (out-of-pocket) or could be used for other productive purposes (foregone opportunity), a suitable charge is justified. The charge for investment is based on the out-of-pocket investment in inventories or added facilities, not on the "book" or accounting value of the investment.

The rate of interest charged on out-of-pocket investment may be based either on the rate paid banks (out-of-pocket) or on the rate of profit that might reasonably be earned by alternative uses of investment (foregone opportunity), depending on the financial policies of the business. In some cases, a bank rate may be used on short-term seasonal inventories and an internal rate for long-term, minimum requirements.

Obviously, much depends on the time scale in classifying a given item. In the short run, few costs are controllable out-of-pocket costs; in the long run, all are.

2. *The costs shall represent only those out-of-pocket expenditures or foregone opportunities for profit whose magnitude is affected by the schedule or plan.* Many overhead costs, such as supervision costs, are out-of-pocket, but neither the timing nor the size is affected by the schedule. Normal material and direct labor costs are unaffected in total and so are not considered directly; however, these as well as some components of overhead cost do represent out-of-pocket investments, and accordingly enter the picture indirectly through any charge for capital.

DIRECT INFLUENCE

Among the costs which directly influence inventory policy are (a) costs depending on the amount ordered, (b) production costs, and (c) costs of storing and handling inventory.

Costs that depend on the amount ordered—These include, for example, quantity discounts offered by vendors; setup costs in internal manufacturing operations and clerical costs of making out a purchase order; and, when capacity is pressed, the profit on production lost during downtime for setup. Shipping costs represent another factor to the extent that they influence the quantity of raw materials purchased and resulting raw stock levels, the size of intraplant or plant-warehouse shipments, or the size and the frequency of shipments to customers.

Production costs—Beyond setup or change-over costs, which are included in the preceding category, there are the abnormal or nonroutine costs of production whose size may be affected by the policies or control methods used. (Normal or standard raw material and direct labor costs are not significant in inventory control; these relate to the total quantity sold rather than to the amount stocked.) Overtime, shakedown, hiring, and training represent costs that have a direct bearing on inventory policy.

To illustrate, shakedown or learning costs show up wherever output during the early part of a new run is below standard in quantity or quality. A cost of undercapacity operation may also be encountered—for example, where a basic labor force must be maintained regardless of volume (although sometimes this can be looked on as part of the fixed facility cost, despite the fact that it is accounted for as a directly variable labor cost).

Costs of handling and storing inventory—In this group of costs affected by control methods and inventory policies are expenses of handling products in and out of stock, storage costs such as rent and heat, insurance and taxes, obsolescence and spoilage costs, and capital costs (which will receive detailed examination in the next section).

Inventory obsolescence and spoilage costs may take several forms, including (1) outright spoilage after a more or less fixed period; (2) risk that a particular unit in stock or a particular product number will (a) become technologically unsalable, except perhaps at a discount or as spare parts, (b) go out of style, or (c) spoil.

CAPITAL INVESTMENT

Evaluating the effect of inventory and scheduling policy upon capital investment and the worth of capital tied up in inventories is one of the most difficult problems in resolving inventory policy questions.

Think for a moment of the amount of capital invested in inventory. This is the out-of-pocket, or avoidable, cash cost for material, labor, and overhead of goods in inventory (as distinguished from the "book" or accounting value of inventory). For example, raw materials are normally purchased in accordance with production schedules; and if the production of an item can be postponed, buying and paying for raw materials can likewise be put off.

Usually, then, the raw material cost component represents a part of the out-of-pocket inventory investment in finished goods. However, if raw materials must be purchased when available (e.g., agricultural crops) regardless of the production schedule, the raw material component of finished product cost does not represent avoidable investment and therefore should be struck from the computation of inventory value for planning purposes.

As for maintenance and similar factory overhead items, they are usually paid for the year round, regardless of the timing of production scheduled; therefore these elements of burden should not be counted as part of the product investment for planning purposes. (One exception: if, as sometimes happens, the maintenance costs actually vary directly with the production rate as, for example, in the case of supplies, they should of course be included.)

Again, supervision, at least general supervision, is usually a fixed monthly cost which the schedule will not influence, and hence should not be included. Depreciation is another type of burden item representing a charge for equipment and facilities already bought and paid for; the timing of the production schedule cannot influence these past investments and, while they represent a legitimate cost for accounting purposes, they should not be counted as part of the inventory investment for inventory and production planning purposes.

In sum, the rule is this: for production planning and inventory management purposes, the investment value of goods in inventory should be taken as the cash outlay made at the time of production that could have been delayed if the goods were not made then but at a later time, closer to the time of sale.

Cost of Capital Invested. This item is the product of three factors: (a) the capital value of a unit of inventory, (b) the time a unit of product is in inventory, and (c) the charge or imputed interest rate placed against a dollar of invested cash. The first factor was mentioned above. As for the second, it is fixed by management's inventory policy decisions. But these decisions can be made economically only in view of the third factor. This factor depends directly on the financial policy of the business.

Sometimes businessmen make the mistake of thinking that cash tied up in inventories costs nothing, especially if the cash to finance inventory is generated internally through profits and depreciation. However, this implies that the cash in inventories would otherwise sit idle. In fact, the cash could, at least, be invested in government bonds if not in inventories. And if it were really idle, the cash very likely should be released to stockholders for profitable investment elsewhere.

Moreover, it is dangerous to assume that, as a "short-term" investment, inventory is relatively liquid and riskless. Businessmen say, "After all, we

turn our inventory investment over six times a year." But, in reality, inventory investment may or may not be short-term and riskless, depending on circumstances. No broad generalization is possible, and each case must be decided on its own merits.

Finally, it might be pointed out that the cost of the dollars invested in inventory may be underestimated if bank interest rate is used as the basis, ignoring the risk-bearing or entrepreneur's compensation. How many businessmen are actually satisfied with uses of their companies' capital funds which do not earn more than a lender's rate of return? In choosing a truly appropriate rate—a matter of financial policy—the executive must answer some questions:

1. Where is the cash coming from—inside earnings or outside financing?
2. What else could we do with the funds, and what could we earn?
3. When can we get the investment back out, if ever?
4. How much risk of sales disappointment and obsolescence is really connected with this inventory?
5. How much of a return do we want, in view of what we could earn elsewhere or in view of the cost of money to us and the risk the inventory investment entails?

Investment in Facilities. Valuation of investment in facilities is generally important only in long-run planning problems—as, for example, when increases in productive or warehouse capacity are being considered. (Where facilities already exist and are not usable for other purposes, and where planning or scheduling do not contemplate changing these existing facilities, investment is not affected.)

Facilities investment may also be important where productive capacity is taxed, and where the form of the plan or schedule will determine the amount of added capacity which must be installed, either to meet the plan itself or for alternative uses. In such cases, considerable care is necessary in defining the facilities investment in order to be consistent with the principles noted above: i.e., that facilities investment should represent out-of-pocket investment, or, alternatively, foregone opportunities to make out-of-pocket investment elsewhere.

CUSTOMER SERVICE

An important objective in most production planning and inventory control systems is maintenance of reasonable customer service. An evaluation of the worth of customer service, or the loss suffered through poor service, is an important part of the problem of arriving at a reasonable inventory policy. This cost is typically very difficult to arrive at, including as it does the paper work costs of rehandling back orders and, usually much more important, the effect that dissatisfaction of customers may have on future profits.

In some cases it may be possible to limit consideration to the cost of producing the needed material on overtime or of purchasing it from the outside and losing the contribution to profit which it would have made. On the other hand, sometimes the possible loss of customers and their sales over a substantial time may outweigh the cost of direct loss in immediate business, and it may be necessary to arrive at a statement of a "reasonable" level of customer service—i.e., the degree of risk of running out of stock, or perhaps the number of times a year the management is willing to run out of an item. In other cases, it may be possible to arrive at a reasonable maximum level of sales which the company is prepared to meet with 100% reliability, being reconciled to have service suffer if sales exceed this level.

One of the uses of the analytic techniques described below and in following parts of this series is to help management arrive at a realistic view of the cost of poor service, or of the value of building high service, by laying out clearly what the cost in inventory investment and schedule changes is to achieve this degree of customer service. Sometimes when these costs are clearly brought home, even a 100% service-minded management is willing to settle for a more realistic, "excellent" service at moderate cost, instead of striving for "perfect" service entailing extreme cost.

OPTIMUM LOT SIZE

Now, with this background, let us examine in some detail one of the inventory problems which plague businessmen the most—that of the optimum size of lot to purchase or produce for stock. This happens also to be one of the oldest problems discussed in the industrial engineering texts—but this does not lessen the fact that it is one of the most profitable for a great many companies to attack today with new analytic techniques.

COMMON PRACTICES

This problem arises, as mentioned earlier, because of the need to purchase or produce in quantities greater than will be used or sold. Thus, specifically, businessmen buy raw materials in sizable quantities—carloads, or even trainloads—in order to reduce the costs connected with purchasing and control, to obtain a favorable price, and to minimize handling and transportation costs. They replenish factory in-process stocks of parts in sizable quantities to avoid, where possible, the costs of equipment setups and clerical routines. Likewise, finished stocks maintained in warehouses usually come in shipments substantially greater than the typical amount sold at once, the motive again being, in part, to avoid equipment setup and paper-work costs and, in the case of field warehouses, to minimize shipping costs.

Where the same equipment is used for a variety of items, the equipment will be devoted first to one item and then to another in sequence, with the length of the run in any individual item to be chosen, as far as is economically possible, to minimize change-over cost from one item to another and to reduce the production time lost because of clean-out requirements during change-overs. Blocked operations of this sort are seen frequently, for example, in the petroleum industry, on packaging lines, or on assembly lines where change-over from one model to another may require adjustment in feed speeds and settings and change of components.

In all these cases, the practice of replenishing stocks in sizable quantities compared with the typical usage quantity means that inventory has to be carried; it makes it possible to spread fixed costs (e.g., setup and clerical costs) over many units and thus to reduce the unit cost. However, one can carry this principle only so far, for if the replenishment orders become too large, the resulting inventories get out of line, and the capital and handling costs of carrying these inventories more than offset the possible savings in production, transportation, and clerical costs. Here is the matter, again, of striking a balance between these conflicting considerations.

Even though formulas for selecting the optimum lot size are presented in many industrial engineering texts, few companies make any attempt to arrive at an explicit quantitative balance of inventory and change-over or setup costs. Why?

For one thing, the cost elements which enter into an explicit solution frequently are very difficult to measure, or are only very hazily defined. For example, it may be possible to get a fairly accurate measure of the cost of setting up a particular machine, but it may be almost impossible to derive a precise measure of the cost of making out a new production order. Again, warehouse costs may be accumulated separately on the accounting records, but these rarely show that the cost of housing an *additional* unit of material may be. In my experience the capital cost, or imputed interest cost, connected with inventory investment never appears on the company's accounting records.

Furthermore, the inventory is traditionally valued in such a way that the true incremental investment is difficult to measure for scheduling purposes. Oftentimes companies therefore attempt to strike only a qualitative balance of these costs to arrive at something like an optimum- or minimum-cost reorder quantity.

Despite the difficulty in measuring costs—and indeed because of such difficulty—it is eminently worthwhile to look at the lot size problem explicitly formulated. The value of an analytic solution does not rest solely on one's ability to plug in precise cost data to get an answer. An analytic solution often helps clarify questions of principle, even with only crude data available for use.

CASE EXAMPLE

To illustrate how the lot size problem can be attacked analytically—and what some of the problems and advantages of such an attack are—let us take a fictitious example. The situation is greatly oversimplified on purpose to get quickly to the heart of the analytic approach.

Elements of the Problem. Brown and Brown, Inc., an automotive parts supplier, produces a simple patented electric switch on long-term contracts. The covering is purchased on the outside at $0.01 each, and 1,000 are used regularly each day, 250 days per year.

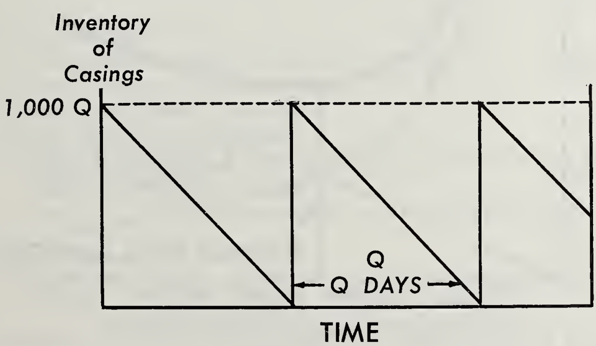
The casings are made in a nearby plant, and B. and B. sends its own truck to pick them up. The cost of truck operation, maintenance, and the driver amounts to $10 per trip.

The company can send the truck once a day to bring back 1,000 casings for that day's requirements, but this makes the cost of a casing rather high. The truck can go less frequently, but this means that it has to bring back more than the company needs for its immediate day-to-day purposes.

The characteristic "saw-tooth" inventory pattern which will result is shown in EXHIBIT I, where 1,000 Q casings are picked up each trip (Q being whatever number of days' supply is obtained per replenishment trip). These are used up over a period of Q days. When the inventory is depleted again, another trip is made to pick up Q days' supply or 1,000 Q casings once more, and so on.

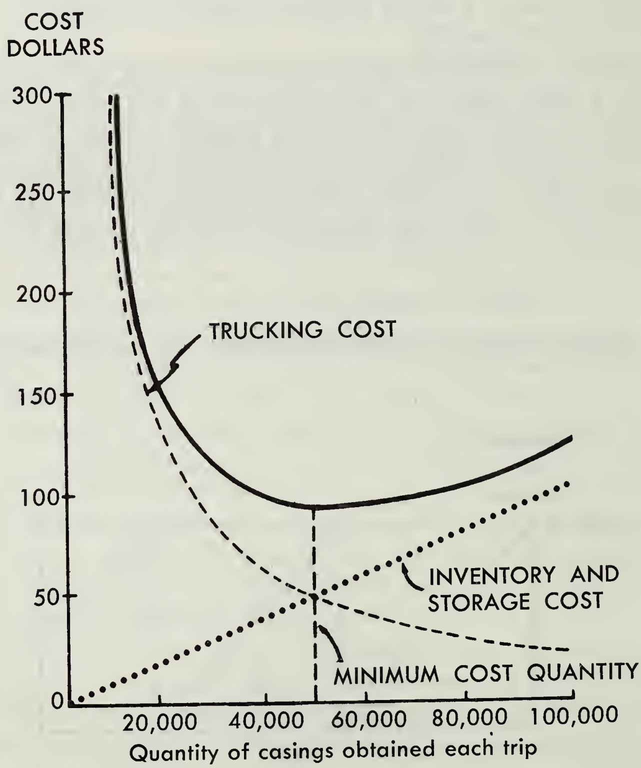
EXHIBIT I. PATTERN OF INVENTORY BALANCE

(1,000 Q casings obtained per replenishment trip; 1,000 casings used per day)



B. and B. estimates that the cost of storing casings under properly controlled humidity conditions is \$1 per 1,000 casings per year. The company wants to obtain a 10% return on its inventory investment of \$10 (1,000 times \$0.01), which means that it should properly charge an additional \$1 (10% of \$10), making a total inventory cost of \$2 per 1,000 casings per year.

EXHIBIT II. ANNUAL COST OF BUYING, MOVING, AND STORING CASINGS COMPARED WITH REORDER QUANTITY



(Note that, in order to avoid undue complications, the inventory investment charge is made here only against the purchase price of the casings and not against the total delivery cost including transportation. Where transportation is a major component of total cost, it is of course possible and desirable to include it in the base for the inventory charge.)

Graphic Solution. Brown and Brown, Inc., can find what it should do by means of a graph (see EXHIBIT II) showing the annual cost of buying, moving, and storing casings:

The broken line shows total trucking costs versus the size of the individual purchase quantity:

If 1,000 casings are purchased at a time, the total cost is \$10 times 250 trips, or \$2,500 per year.
If 10,000 casings are purchased at one time, only 25 trips need be made, for a total cost of \$250 per year.
If 100,000 casings are purchased, only 2½ trips, on the average, have to be taken each year, for a total cost of \$25.

The dotted line shows the inventory cost compared with the size of the purchased quantity:

If 10,000 casings are purchased at one time, the inventory at purchase will contain 10,000, and it will gradually be depleted until none are on hand, when a new purchase will be made. The average inventory on hand thus will be 5,000 casings. The cost per year will be \$2 times 5,000 casings, or \$10.

EXHIBIT III. EXAMPLE OF ALGEBRAIC SOLUTION OF SAME INVENTORY PROBLEM AS EXHIBIT II

The total annual cost of supplying casings is equal to the sum of the direct cost of the casings, plus the trucking cost, plus the inventory and storage cost.

Let:

T = total annual cost
b = unit purchase price, \$10 per 1,000 casings
s = annual usage, 250,000 casings
A = trucking cost, \$10 per trip
N = number of trips per year
i = cost of carrying casings in inventory at the annual rate of \$2 per 1,000, or \$0.002 per casing
x = size of an individual purchase ($x/2$ = average inventory)

The basic equation will be:

$$T = bs + AN + ix/2$$

The problem is to choose the minimum-cost value of x (or, if desired, N). Since x is the same as s/N, N can be expressed as s/x. Substituting s/x for N in the above equation, we get:

$$T = bs + As/x + ix/2$$

From this point on we shall use differential calculus. The derivative of total cost, T, with respect to x will be expressed as:

$$dT/dx = -As/x^2 + i/2$$

And the minimum-cost value of x is that for which the derivative of total cost with respect to x equals zero. This is true when:

$$x = \sqrt{2As/i}$$

Substituting the known values for A, s, and i:

$$x = \sqrt{2 \cdot 10 \cdot 250{,}000/.002} = 50{,}000 \text{ casings}$$

Similarly, if 100,000 casings are purchased at one time, the average inventory will be 50,000 casings, and the total inventory and storage cost will be $100.

The solid line is the total cost, including both trucking and inventory and storage costs. The total cost is at a minimum when 50,000 casings are purchased on each trip and 5 trips are made each year, for at this point the total trucking cost and the total inventory and storage cost are equal.

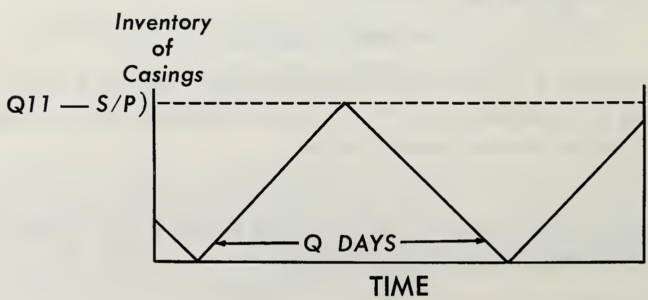
The solution to B. and B.'s problem can be reached algebraically as well as graphically. EXHIBIT III shows how the approach works in this very simple case.

SIMILAR CASES

The problem of Brown and Brown, Inc., though artificial, is not too far from the questions many businesses face in fixing reorder quantities.

Despite the simplifications introduced—for example, the assumption that usage is known in advance—the method of solution has been found widely useful in industries ranging from mail order merchandising (replenishing staple lines), through electrical equipment manufacturing (ordering machined parts to replenish stockrooms), to shoe manufacturing (ordering findings and other purchased supplies). In particular, the approach has been found helpful in controlling stocks made up of many low-value items used regularly in large quantities.

EXHIBIT IV. INFLUENCE OF PRODUCTION AND SALES RATE ON PRODUCTION CYCLE INVENTORY



A number of realistic complications might have been introduced into the Brown and Brown, Inc., problem. For example:

In determining the size of a manufacturing run, it sometimes is important to account explicitly for the production and sales rate. In this case, the inventory balance pattern looks like EXHIBIT IV instead of the saw-tooth design in EXHIBIT I. The maximum inventory point is not equal to the amount produced in an individual run, but to that quantity less the amount sold during the course of the run. The maximum inventory equals $Q\ (1 - S/P)$, where Q is the amount produced in a single run, and S and P are the daily sales and production rates respectively.

This refinement can be important, particularly if the sales rate is fairly large compared with the production rate. Thus, if the sales rate is half the production rate, then the maximum inventory is only half the quantity made in one run, and the average inventory equals only one-fourth the individual run quantity. This means that substantially more inventory can be carried—in fact, about 40% more.

When a number of products are made on a regular cycle, one after another, with the sequence in the cycle established by economy in change-over cost, the total cycle length can be obtained in the same way as described above. Of course, it sometimes happens that there is a periodic breach in the cycle, either to make an occasional run of a product with very low sales or to allow for planned maintenance of equipment; the very simple run-length formulas can be adjusted to allow for this.

Other kinds of costs can also be included, such as different sorts of handling costs. Or the inventory cost can be defined in such a way as to include transportation, obsolescence, or even capital and storage cost as part of the unit value of the product against which a charge for capital is made. When a charge for capital is included as part of the base value in computing the cost of capital, this is equivalent to requiring that capital earnings be compounded; this can have an important bearing on decisions connected with very low volume items which might be purchased in relatively large, long-lasting quantities.

Complications such as the foregoing, while important in practice, represent changes in arithmetic rather than in basic concept.

SIGNIFICANT CONCLUSIONS

When the analytic approach is applied to Brown and Brown's problem and similar cases, it reveals certain relationships which are significant and useful to executives concerned with inventory management:

1. *The appropriate order quantity and the average inventory maintained do not vary directly with sales.* In fact, both of these quantities vary with the square root of sales. This means that with the same ordering and setup cost characteristics, the larger the volume of sales of an item, the less inventory per unit of sales is required. One of the sources of inefficiency in many inventory control systems is the rigid adoption of a rule for ordering or carrying inventory equivalent to, say, one month's sales.

2. *The total cost in the neighborhood of the optimum order quantity is relatively insensitive to moderately small changes in the amount ordered.* Exhibit II illustrates this proposition. Thus, all that is needed is just to get in the "right ball park," and a good answer can be obtained even with fairly crude cost data. For example, suppose the company had estimated that its total cost of holding 1,000 casings in inventory for a year was $1 when it actually was $2 (as in our illustration). Working through the same arithmetic, the company would have arrived at an optimum order quantity of 70,000 casings instead of 50,000. Even so, the total cost would have been (using the correct $2 annual carrying cost):

3.6 trips per year @ $10	=	$36
35,000 casings average inventory @ $0.002	=	70
Total annual cost	=	$106

Thus, an error of a factor of 2 in one cost results in only a 6% difference in total cost.

In summary, Brown and Brown's problem, despite its oversimplification, provides an introduction to the analytic approach to inventory problems.

In particular, it illustrates the first essential in such an approach—i.e., defining an inventory function. In this case the function is to permit purchase or manufacture in economical order quantities or run lengths; in other cases it may be different. The important point is that this basic function can be identified wherever it may be found—in manufacturing, purchasing, or warehouse operation.

The only way to cut inventories is to organize operations so that they are tied more closely together. For example, a company can cut its raw materials inventory by buying in smaller quantities closer to needs, but it does so at a cost; this cost results from the increased clerical operations needed to tie the purchasing function more closely to manufacturing and to keep it more fully informed of manufacturing's plans and operations. The right inventory level is reached when the cost of maintaining any additional inventory cushion offsets the saving that the additional inventory earns by permitting the plant to operate in a somewhat less fully organized fashion.

B. and B.'s problem also illustrates problems and questions connected with defining and making costs explicit. The inventory capital cost is usually not found on a company's books, but it is implied in some of the disagreements over inventory policy. Here, again, bringing the matter into the open may help each side in a discussion to recognize its own and the others' hidden assumptions, and thus more quickly to reach a common agreement.

25. GUIDES TO INVENTORY POLICY II. PROBLEMS OF UNCERTAINTY

John F. Magee*

The discussion of factors influencing the inventory is considered in light of the reorder problems and also production scheduling. Difficulties of policy are illustrated in an extended inventory and production scheduling case.

Marketing and production executives alike have an immediate, vital interest in safety stocks. In these days of strong but often unpredictable sales, safety stocks afford, for the factory as well as for the sales office, a method of buying short-term protection against the uncertainties of customer demand. They are the additional inventory on hand which can be drawn upon in case of emergency during the period between placement of an order by the customer and receipt of the material to fill the order. However, in practice their potentials are often needlessly lost.

Our studies have shown that the methods used by existing systems in industry often violate sound control concepts. The economy of the company is maintained, in the face of instability and inefficiency in the inventory control system, only because of constant attention, exercise of overriding common sense, and use of expediting and other emergency measures outside the routine of the system.

Actually, it is possible to have inventory controls which are not only flexible but also carefully designed and explicit. But the task needs special analytical tools; in a complicated business it defies common sense judgment and simple arithmetic. Methods must be employed to take direct account of uncertainty and to measure the response characteristics of the system and relate them to costs. Such methods are the distinctive mark of a really modern, progressive inventory control system.

BASIC SYSTEMS

Like transit stocks and lot-size stocks, safety stocks "decouple" one stage in production and distribution from the next, reducing the amount of over-all organization and control needed.

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* From *Harvard Business Review,* XXXIV, 2 (1956), 103-16. Reprinted by permission of the *Harvard Business Review.*

But the economies of safety inventories are not fairly certain and immediate. The objective is to arrive at a reasonable balance between the costs of the stock and the protection obtained against inventory exhaustion. Since exhaustion becomes less likely as the safety inventory increases, each additional amount of safety inventory characteristically buys relatively less protection. The return from increasing inventory balances therefore diminishes rapidly. So the question is: How much additional inventory as safety stock can be economically justified?

To answer this question we need to look at the two basic systems of inventory replenishment to handle uncertainty about sales and see how they produce different results.

FIXED ORDER

Under any fixed order system—the old-fashioned "two-bin" system or one of its modern varieties—the same *quantity* of material is always ordered (a binful in the primitive system), but the *time* an order is placed is allowed to vary with fluctuations in usage (when the bottom of one bin is reached). The objective is to place an order whenever the amount on hand is just sufficient to meet a "reasonable" maximum demand over the course of the lead time which must be allowed between placement of the replenishment order and receipt of the material.

Where the replenishment lead time is long (e.g., three months) compared with the amount purchased at each order (e.g., a one-month supply), there are presumably some purchase orders outstanding all the time which, on being filled, will help replenish the existing inventory on hand. In such cases, of course, the safety stocks and reorder points should be based upon both amount on hand and on order. Where, on the other hand, the lead time is short compared with the quantity ordered, as in most factory two-bin systems, the amount on hand and the total on hand and on order are in fact equivalent at the time of reordering.

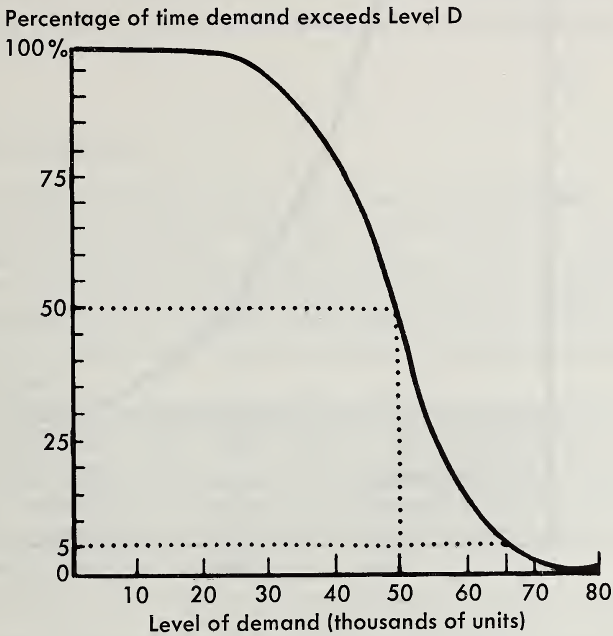
The key to setting the safety stock is the "reasonable" maximum usage during the lead time. What is "reasonable" depends partly, of course, on the nature of short-term fluctuations in the rate of sale. It also depends—and here is where the top executive comes foremost into the picture—on the risk that management is prepared to face in running out of stock. What is the level of sales or usage beyond which management is prepared to face the shortages? For example:

In EXHIBIT I, continuing the hypothetical case of Brown and Brown, Inc.,[1] the curve shows the number of weeks in which the demand for casings may be expected to equal or exceed any specified level. (Such a curve could be roughly plotted according to actual experience modified by such expectations or projections as seem warranted; refinement can be added by the use of mathematical analysis when such precision seems desirable.)

[1] See page 225 (Article 24).

Now, if it takes B. and B. a week to replenish its stocks and the management wishes to keep the risk of running out of stock at a point where it will be out of stock only once every 20 weeks, or 5% of the time, then it will have to schedule the stock replenishment when the inventory of casings on hand drops to 66,000 units. Since the expected or average weekly usage is 50,000 units, the safety stock to be maintained is 16,000 (making a total stock of 66,000).

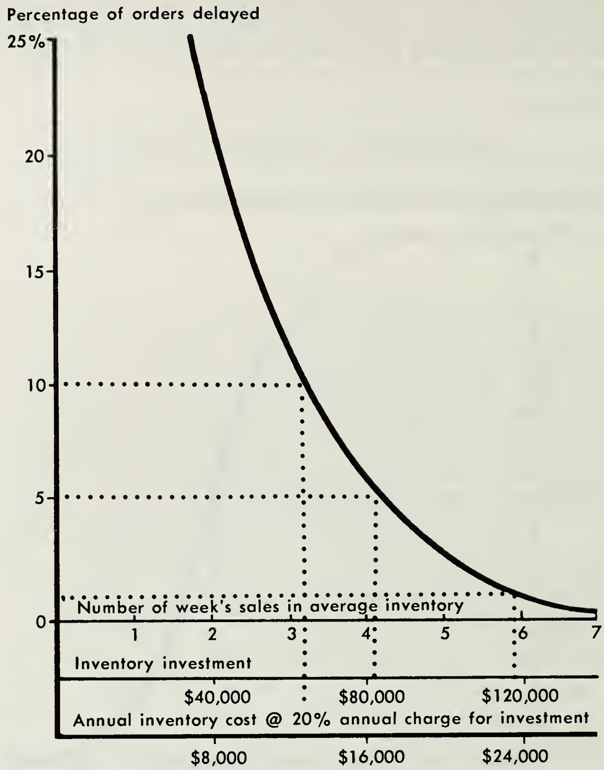
EXHIBIT I. BROWN AND BROWN'S SAFETY STOCK



This example, of course, assumes a single, rather arbitrary definition of what is meant by risk or minimum acceptable level of customer service. There are a number of ways of defining the level of service, each appropriate to particular circumstances. One might be the total volume of material or orders delayed; another, the number of customers delayed (perhaps only in the case of customers with orders exceeding a certain size level), still another the length of the delays. All of these definitions are closely related to the "probability distribution" of sales—i.e., to the expected pattern of sales in relation to the average.

Cost of Service Failure. It is easy enough to understand the principle that setting a safety stock implies some kind of a management decision or judgment with respect to the maximum sales level to be allowed for, or

EXHIBIT II. RELATION BETWEEN SAFETY STOCKS AND ORDER DELAY



the cost of service failure. But here is the rub: service failure cost, though real, is far from explicit. It rarely, if ever, appears on the accounting records of the company except as it is hidden in extra sales or manufacturing costs, and it is characteristically very hard to define. What is new in inventory control is not an accounting technique for measuring service cost but a method of self-examination by management of the intuitive assumptions it is making. The progressive company looks at what it is in fact assuming as a service-failure cost in order to determine whether the assumed figure is anywhere near realistic.

For example, characteristically one hears the policy flatly stated: "Back orders are intolerable." What needs to be done is to convert this absolute, qualitative statement into a quantitative one of the type shown in EXHIBIT II. Here we see the facts which might be displayed for the management of a hypothetical company to help it decide on a customer service policy:

To get a 90% level of customer service (i.e., to fill 90% of the orders immediately), a little over three weeks' stock must be carried—an investment of $64,000 with an annual carrying cost of $12,800.

Filling another 5% of orders immediately, thereby increasing the service level to 95%, would mean about one week's more stock, with an extra annual cost of $3,800.

Filling another 4% immediately (a 99% service level) would cost an extra $7,400 per year.

At each point the management can decide whether the extra cost is justified by the improved service. Thus, the chart becomes a device for comparing policies on service and inventories for consistency and rationality.

PERIODIC REORDERING

The periodic reordering system of inventory replenishment—the other basic approach to handling uncertainty about demand—is very popular, particularly where some type of book inventory control is employed and where it is convenient to examine inventory stocks on a definite schedule. The idea underlying all varieties of this system is to look at stocks at fixed *time* intervals, and to vary the order *amount* according to the usage since the last review.

The problem is that many seemingly similar ways of handling a cyclical ordering system may have hidden traps. A typical difficulty is instability in reordering habits and inventory levels caused by "overcompensation"; that is, by attempting to outguess the market and assuming that high or low sales at one point, actually due to random causes, indicate an established trend which must be anticipated.

The most efficient and stable reorder scheme or rule has a very simple form:

> A forecast or estimate of the amount to be used in the future is made for a period equal to the delivery lead time plus one reorder cycle. Then an order is placed to bring the total inventory on hand and on order up to the total of the amount forecast for the delivery lead and cycle times, plus a standard allowance for safety stock. Under such a scheme, the average inventory expected to be on hand will be the safety balance plus one-half the expected usage during a reorder cycle.

Many companies subscribe to this plan wholeheartedly in principle but only halfheartedly in practice. A common tendency, for instance, is to make the forecast but then, if sales increase, to revise it upward and transmit the increase back to the plant. The whole value of a safety stock based on a balancing of the costs of running out and the costs of rush orders to production is thus lost.

Readers may recognize the application here of servo theory, the body of concepts (including feedback, lags or reaction times, type of control, and the notion of stability) developed originally by electrical engineers in designing automatic or remotely controlled systems. An inventory system, though not a mechanical device, is a control system and as a consequence is subject to the same kinds of effects as mechanical control systems and can be analyzed using the same basic concepts.

CHOICE OF SYSTEM

Each system of reordering inventories has its own advantages. Here are the conditions under which the fixed order system is advantageous:

Where some type of continuous monitoring of the inventory is possible, either because the physical stock is seen and readily checked when an item is used or because a perpetual inventory record of some type is maintained.

Where the inventory consists of items of low unit value purchased infrequently in large quantities compared with usage rates; or where otherwise there is less need for tight control.

Where the stock is purchased from an outside supplier and represents a minor part of the supplier's total output, or is otherwise obtained from a source whose schedule is not tightly linked to the particular item or inventory in question; and where irregular orders for the item from the supplier will not cause production difficulties.

For example, the fixed order system is suitable for floor stocks at the factory, where a large supply of inexpensive parts (e.g., nuts and bolts) can be put out for production workers to draw on without requisitions, and where a replenishment is purchased whenever the floor indicates the supply on hand has hit the reorder point.

By contrast, the periodic reordering system is useful under these conditions:

Where tighter and more frequent control is needed because of the value of the items.

Where a large number of items are to be ordered jointly, as in the case of a warehouse ordering many items from one factory. (Individual items may be shipped in smaller lots, but the freight advantages on large total shipments can still be obtained.)

Where items representing an important portion of the supplying plant's output are regularly reordered.

In general, since safety stocks needed vary directly with the length of the period between orders, the periodic system is less well suited where the cost of ordering and the low unit value of the item mean infrequent large orders.

It should be noted that modifications of the simplest fixed order system or intermediates between the fixed order system and the periodic reordering system are also possible and very often useful; they can combine the

better control and cost features of each of the "pure" schemes. For example:

> One type of scheme often useful—the "base stock" system—is to review inventory stocks on a periodic basis but to replenish these stocks only when stocks on hand and on order have fallen to or below some specified level. When this happens, an order is placed to bring the amount on hand and on order up to a specified maximum level.
>
> The choice of frequency of review and the minimum and maximum inventory points can be determined by analysis similar to that used for the other systems, but precautions must be taken—such as that stocks on order must always be counted when reorder quantities are figured—in order to avoid problems of instability and oscillation which can easily creep into rules that are apparently sound and sensible.

Interaction Among Factors. As mathematical analysis will indicate, the safety stock, reorder quantity, and reorder level are not entirely independent under either the fixed order or the periodic reordering system (or any combination thereof):

> Where the order amount is fixed, the safety stock is protection against uncertainty over the replenishment time (measured by the reorder level). But it is the size of the order amount that determines the frequency of exposure to risk. With a given safety level, the bigger the order placed, the less frequently will the inventory be exposed to the possibility of run-out and the higher will be the level of service.
>
> Where inventories are reordered on a periodic time cycle, the uncertainty against which safety stocks protect extends over the *total* of the reorder period and replenishment time. But here it is the length of the reordering cycle that determines the risk. The shorter the period and the closer together the reorders, the less will be the chance of large inventory fluctuations and, as a consequence, the less will be the size of safety stock required in order to maintain a given level of service.

The interaction among the frequency of reorder, the size of reorder, and safety stocks is often ignored as being unimportant, even in setting up fairly sophisticated inventory control schemes (although the same companies readily consider the *lot-size* problem in relation to the other factors). In many cases this may be justifiable for the purpose of simplifying inventory control, particularly methods for adjusting reorder quantities and safety stocks to changing costs and sales. On the other hand, cases do arise from time to time where explicit account must be taken of such interactions so that an efficient system may be developed.

Note, too, that the factors governing the choice of any reorder scheme are always changing. Therefore, management should provide for routine review of the costs of the system being used, once a year or oftener, so that trends can be quickly identified. Also, control chart procedures, like simple quality control methods, should be used to spot "significant" shifts in usage rates and in the characteristics of customer demand (fluctuations,

order size, frequency of order, etc.). Schemes for checking such matters each time a reorder point is crossed are easily incorporated in the programs of automatic data-handling systems used for inventory control; they can also be applied to manual systems, but less easily and hence with some temptation to oversimplify them dangerously.

PRODUCTION SCHEDULING

Now let us turn to the important relationships between safety stocks and production. The safety stock affects, and is affected by, production run cycles, production "reaction times," and manufacturing capacity levels.

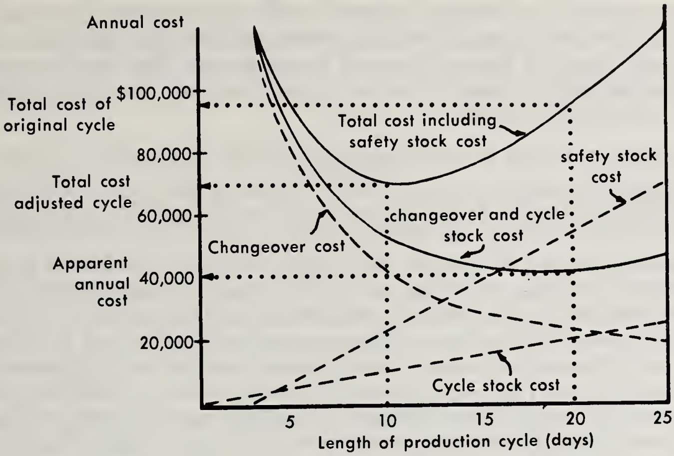
SETTING CYCLE LENGTHS

In production cycling problems, as in periodic reordering, the longer the run on each product, the longer one must wait for a rerun of that product; therefore, a larger safety stock must be maintained as protection. Shorter, more frequent runs give greater flexibility and shorter waiting periods between runs, and thus lower safety inventory requirements. Also, again the interaction between factors must be taken into account. For example:

A chemical company arrived at production run cycles for a set of five products going through the same equipment on the basis of only setup costs and cycle inventories (e.g., lot-size inventories), ignoring the interaction between cycle length and safety stocks. It found that on this basis an over-all product cycle of approximately 20 days, or one production month, appeared optimum, allowing 4 days per product on the average. However, when the problem was later re-examined, it was discovered that the uncertainty introduced by long lead times was so great that the over-all product cycle could in fact be economically cut back to less than 10 days. Doubling setup costs would be more than offset by savings in inventory and storage costs resulting from a reduction in the needed safety stocks.

EXHIBIT III illustrates the cost characteristics found to exist. The three *dashed* lines show separately the annual costs of changeovers, carrying cycle inventories, and carrying safety stocks, compared with the length of the individual production cycle. Adding together only the first two costs leads to the lower of the *solid* lines. This is at a minimum when the production cycle is 20 days long, indicating an apparent annual cost of $40,000. However, if *all* costs are included (the *solid* line at the top), the total annual cost on a 20-day cycle is $95,000. On this basis total costs are at a minimum when the cycle is 10 days long—only $70,000. This means a saving of $25,000 annually on the products in question.

EXHIBIT III. INFLUENCE OF SAFETY STOCKS ON CHOICE OF AN OPTIMUM PRODUCTION CYCLE



SETTING PRODUCTION LEVELS

Safety stocks give only short-term protection against sales uncertainty. If stocks are being replenished from production, the effectiveness of over-all control depends also on the ability to restore them in case of depletion.

If total demand varies, the ability to restore stocks depends, in turn, on the ability of the production facilities to react to chance fluctuations. In order to get low inventories, the process must have fast reactions properly controlled or (equivalently) in some cases large "capacity." If reactions are slow or limited, inventories must be large, and the inventory in effect serves another type of protective function, namely, protection of production rate or capacity from the stresses of demand fluctuation.

How fast should production operations respond to sales fluctuations, and to what extent should these fluctuations be absorbed by means of inventory? The costs of warehousing and cash investment in inventory need to be balanced against the costs of changing production rates or building excess capacity into the production system.

The actual cost of making out schedules, which depends on the frequency with which they are made and the degree of precision required, also should be considered, as well as the speed of reaction of production which is physically possible (e.g., the employee training time). When

these costs are made explicit, management may find itself having to balance conflicting objectives. To illustrate:

A metal fabricator making a wide line of products to order attempted to provide immediate service to customers. He found that on the average his departments needed a substantial excess of labor over the normal requirements of the jobs flowing through, and this excess was essentially idle time. On the other hand, when he attempted to cut the excess too thin, backlogs began to build up. He had to weigh his desire to get the lead time down against the costs of excess unused labor.

Ordinarily we want to avoid passing back the full period-to-period sales fluctuation by making corresponding changes in the size of orders placed on production because it is uneconomical. What we can do instead is to:

1. Set the production level in each period equal to anticipated needs over the lead time plus the scheduling period not already scheduled, plus or minus *some fraction* of the difference between desired and actual inventory on hand.
2. Alternatively, change the existing production level or rate by *some fraction* of the difference between the existing rate and the rate suggested by the simple reorder rule (i.e., that an order be placed in each period equal to the anticipated requirements over the lead time plus the scheduling period, plus or minus the difference between desired and actual inventory on hand and on order).

Each of these alternatives is useful in certain types of plants, depending on whether the cost of production fluctuations comes primarily from, say, overtime and undertime (work guarantee) costs or from hiring, training, and layoff costs. Each in appropriate circumstances will lead to smoother production, at the expense of extra inventory to maintain the desired level of service.

When the different costs involved are identified and measured, mathematical techniques can be used to show the effect that varying the numbers in the rule (in particular, the size of the *fraction* used) has on inventory and production expense and to arrive at an economical balance between the needs of marketing and manufacturing. These two rules are expressions of servo theory, like that referred to earlier in connection with inventory. Here it may be worthwhile to see in some working detail how the theory can be applied mathematically:

The first rule can be stated as follows:

$$P_i = \sum_{k=0}^{T} F_{i+k} - \sum_{k=1}^{T} P_{i-k} + k(I_o - I_i) \; ; k \leq 1$$

P_i is the amount scheduled for production in period i, F_i is the forecast requirements for period i, I_o is the desired inventory, I_i is the actual opening inventory on hand in period i, and k is the response number which indicates what fraction of the inventory error or production rate departure is to be accounted for each period.

The fluctuations in inventory resulting from a choice of k in the first rule can be expressed as a function of the fluctuations in sales about the forecast, as follows (if fluctuations from month to month are not correlated):

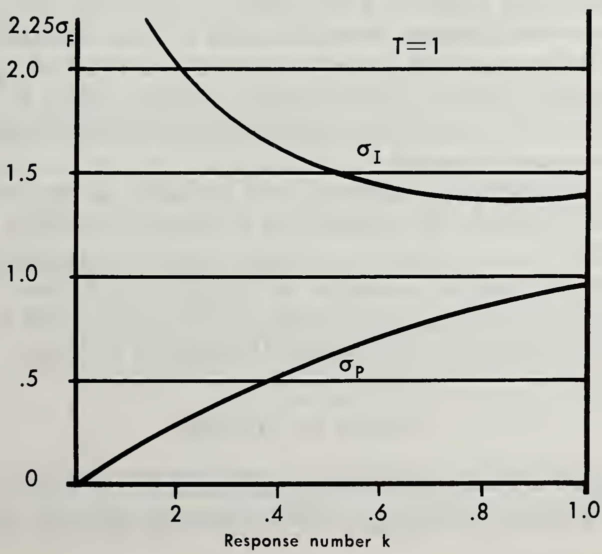
$$\sigma_I = \sqrt{\frac{T(2k - k^2) + 1}{2k - k^2}}\,\sigma_F$$

where σ_I is the standard deviation of inventory levels, and σ_F is the standard deviation of actual sales about forecast sales each period. Similarly, the production rate variations resulting from any choice of k can be expressed as:

$$\sigma_P = \sqrt{\frac{k}{2 - k}}\,\sigma_F$$

The influence of the choice of a response number, k, on the standard deviation of inventories and on the standard deviation of production rates under the first type of rule is shown in EXHIBIT IV. Frequently the costs of production fluctuations are more or less directly proportional to the standard deviation of fluctuations in the production rate, a measure of the amount of change in production level which can be expected to occur. On the other hand, the normal inventory level, the average level expected, must be set large enough so that even with expected inventory fluctuations, service failures will not occur excessively. This means that the larger the standard deviation in inventory levels, the larger must be the normal level, generally in proportion. Therefore, one can "buy" production flexibility with larger inventories, and vice versa, with the particular costs in the process concerned determining the economical balance.

EXHIBIT IV. EFFECT OF RESPONSE NUMBER k ON VARIATIONS IN INVENTORY AND PRODUCTION RATE



The second rule can be worked through similarly. Here P^* is the changed amount scheduled for production, and the rule can be stated as follows:

$$P^*_i = P^*_{i-1} + k(P_i - P^*_{i-1});\ k \leq 1 = (1 - k)P^*_{i-1} + kP_i$$

where

$$P_i = \sum_{k=0}^{T} F_{i+k} - \sum_{k=1}^{T} P^*_{i-k} + (I_o - I_i)$$

SETTING CAPACITY LEVELS

In some cases—particularly where output cannot be stocked easily—the problem of controlling the production level is not so much one of adjusting the level to respond to fluctuations in demand, as of setting the capacity of the plant or operation at a high enough level to permit demand fluctuations to be absorbed without excessive delay. If the capacity is set equal only to the desired average rate, fluctuations in demand about this desired rate must either be absorbed by inventories or by orders piling up in a back-log.

A theory of such processes is growing; it is known as waiting-line theory. This is really a branch of probability theory, and is itself a whole body of mathematical techniqués and explicit concepts providing a mathematical framework within which waiting-line and similar problems can be studied.

Some examples of applications in production scheduling are: flow of orders through departments in a job shop; flow of items through the stages in an assembly line; clerical processing of orders for manufacture or shipping; filling orders in a warehouse or stockroom; and setting up shipping or berth facilities to handle trucks or other transport units. In each case, fairly well-fixed crews or facilities have to be set up for handling fluctuating orders or items quickly, avoiding delays in service. A balance between the cost of extra personnel or facilities and delays in taking care of demand is needed.

In applying waiting-line theory to such problems, the flow of orders or demand for goods can be considered as a demand for service, analogous to subscriber cost in a telephone exchange. Orders are handled by one or more processing stations, analogous to telephone trunk lines. When the order or unit is produced, the processing station is free to take on the next order in line, as when a call is completed through the exchange.

STAGES OF CONTROL

The choice and use of appropriate techniques for inventory control is not a simple matter. It takes a good deal of research into sales and product

characteristics, plus skill in sensing which of many possible approaches are likely to be fruitful.

To describe these techniques, I shall take a case illustration. This case is drawn from a great deal of business experience, but in order to keep the detail and arithmetic within manageable proportions without distorting the essential points, I have simplified and combined everything into one fictional situation.

Any of the stages of the company's progress toward more efficient inventory management—from the original to the final—might be found to exist in the inventory control practices of a number of sizable companies with reputations for progressive and efficient management. These stages of advancement in the refinement of inventory control should not be used to compare the inventory system of one company or division with that of another, for the reasons just mentioned; but they may prove helpful to management in answering the questions, "Where are we now?" and "What could we do better?"

Briefly, the case situation is as follows:

One division of the Hibernian Bay Company makes and sells a small machine part. Sales run slightly over 5,000 units annually, and the price is $100 apiece. Customers are supplied from four branch stock points scattered about the country, which in turn are supplied by the factory warehouse. The machining and assembly operations are conducted in a small plant, employing largely semiskilled female help. The level of production can be changed fairly rapidly but at the cost of training or retraining workers, personnel office expenses, and increased inspection and quality problems. The division management has almost complete autonomy over its operations, although its profit records are closely scrutinized at headquarters in Chicago.

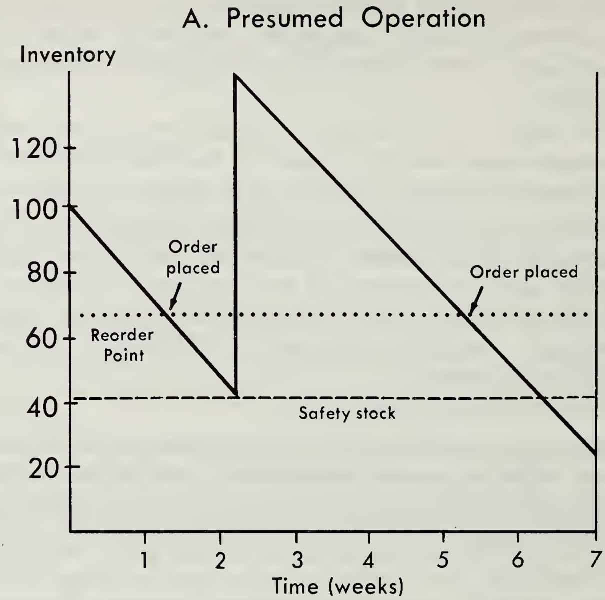
Originally the factory and branch warehouse stocking practices were haphazard and unsatisfactory. In total, nearly four months' stock was carried in branches, in the factory warehouse, or in incompleted production orders. A stock clerk in each branch who watched inventories and placed reorders on the factory warehouse was under pressure to be sure that stocks were adequate to fill customer orders. The factory warehouse reorder clerk in turn watched factory stocks and placed production orders. Production runs or batches were each put through the plant as a unit. Fluctuations in production, even with apparently sizable stocks on hand, caused the management deep concern.

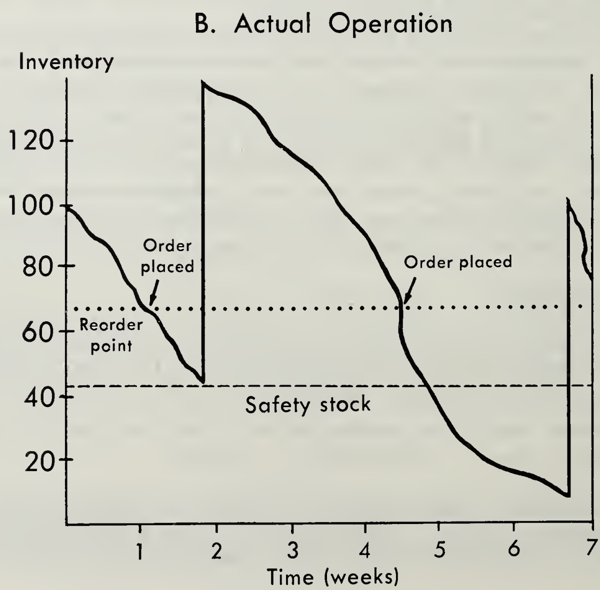
SERVICE IMPROVED

The management decided to try to improve inventory practices and appointed a research team to study the problem. The team suggested using "economical order quantities" for branch orders on the factory warehouse and warehouse orders on production, as a basis for better control. The steps followed were:

The research team suggested that the formula for determining the economical order quantity was $x = \sqrt{2As/i}$, where $A =$ fixed cost connected with an order (setup of machines, writing order, checking receipts, etc.), $i =$ annual

EXHIBIT V. ECONOMICAL REORDER SYSTEM OF A BRANCH WAREHOUSE





cost of carrying a unit in inventory, s = annual movement, and x = "economical order quantity."

The team found that each branch sold an average of 25 units a week, or 1,300 per year; that the cost of a branch's placing and receiving an order was $19 ($6 in clerical costs at the branch and factory, $13 in costs of packing and shipping goods, receiving, and stocking); that annual inventory carrying costs in the branches were $5 per unit, based on a desired 10% return on incremental inventory investment. The reorder quantity for each branch was computed as $\sqrt{2 \cdot \$19 \cdot 1{,}300/\$5} = 100$ unit reorder quantity.

A system was set up where each branch ordered in quantities of 100, on the average, every four weeks. On this basis, without further action, each branch would have had an average inventory of one-half a reorder quantity, or 50 units. (The books would show 75 units, since stock in transit from factory warehouse to branch was also charged to the branch, and with average transit time of one week this would average 25 units.)

The next step was to provide for enough to be on hand when a reorder was placed to last until the order was received. While the average transit time was one week, experience showed that delays at the factory might mean an order would not be received at the branch for two weeks. So sales for two weeks had to be covered.

Statistical analysis showed that sales in any one branch over two weeks could easily fluctuate from 38 units to 62 units and could conceivably go as high as 65-70. The management decided that a 1% chance of a branch running out of stock before getting an order would be adequate.

Calculations then indicated that the maximum reasonable two-week demand to provide for would be 67. (The statistical basis was that sales fluctuate about the average at random; that fluctuations in the various branches are independent of one another; and that the standard deviation is $\sqrt{st}$ where s = sales rate, and t = length of individual time period.)

The branches therefore were instructed to order 100 units whenever the stock on hand and on order was 67 or less. This gave an inventory in each branch made up on the average as follows:

Safety stock	42	(order point, 67, less normal week's usage, 25)
Order cycle stock	50	(one half 100-unit order)
In transit	25	(one week's sales)
Total	117	or 4.7 weeks' sales

The resulting behavior of the reorder system is shown in EXHIBIT V—both as it would be presumed in theory and as it actually turned out. Although the actual performance was much less regular than presumed, the two compare fairly well—testimony to the soundness of the procedure.

APPLICATION AT THE FACTORY

At the factory warehouse end, the "economical order quantity" scheme worked as follows:

The cost of holding a unit in inventory was $3.50 per year (at 10% return on investment); the cost of placing an order and setting up equipment for each order was $13.50; and, of course, a total of 5,200 units was made each year.

These indicated that each production order should be for $\sqrt{2 \cdot \$13.50 \cdot 5{,}200/\$3.50} = 200$ units.

Factory processing time was two weeks; it would take two weeks for each order to reach the warehouse. The warehouse would need to place its replenishment order on the factory when it had enough on hand or on order to fill maximum reasonable demand during the next two weeks.

On the average, the factory warehouse would receive one order a week from the branches (one every four weeks from each of four branches) under the new branch reorder system. In fact, because of the fluctuations in branch sales described before, it was found that orders on the factory warehouse fluctuated substantially in any two-week period (see EXHIBIT VI).

EXHIBIT VI. FLUCTUATIONS OF ORDERS ON FACTORY WAREHOUSE

Number of branch orders	*Number of items ordered*	*Percentage of weeks*
	A. *Weekly Periods*	
0	0	37%
1	100	37
2	200	18
3	300	6
4+	400+	2
	B. *Biweekly Periods*	
0	0	13%
1	100	27
2	200	27
3	300	18
4	400	9
5	500	4
6	600	1
7+	700+	1

It was agreed that to give branches service adequate to maintain their own service, stocks at the factory warehouses would have to be high enough to fill demand 99% of the time, i.e., a replenishment order would have to be placed when 600 units were on hand. This meant a safety stock of 600 units minus 200 (normal usage), or 400 units. Cycle stock averaged half a run, or 100 units, and stock in process an additional half run, or 100 units. Total factory stock, then, was:

Cycle stock	100 units
Stock in process	100
Safety stock	400
Total	600 units

EXHIBIT VII gives a picture of the apparent costs of the "economical order" system. The stock of 1,068 units equaled less than 11 weeks' sales, a fairly substantial reduction, and the management felt that it had a better control, since clerical procedures were set up to adapt readily to any

changes in inventory charges (currently 10% per year) or service level requirements the management might choose to make.

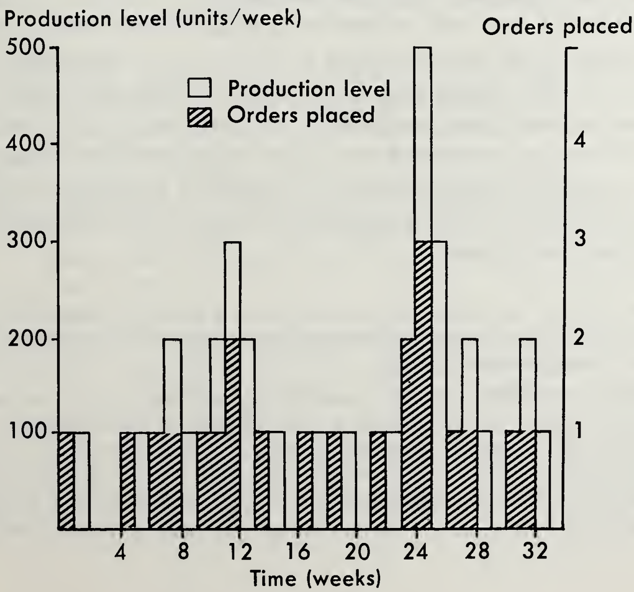
EXHIBIT VII. COSTS OF REORDER SYSTEM

	Number	*Cost each*	*Annual cost*
Inventory			
Factory	600 units	$3.50/year	$2,100
4 branches	468 units	$5.00/year	2,340
Reorder cost			
Branch	52/year	$19.00	990
Factory	26/year	$13.50	350
Total			$5,780

PRODUCTION STABILIZED

But the factory still had problems. On the average, the warehouse would place one production order every two weeks, but experience showed that in 60% of the weeks no orders were placed, in 30% one order, and in 10% two, three, or more orders were placed. EXHIBIT VIII shows orders on the factory and the production level for a representative period of weeks.

EXHIBIT VIII. FACTORY ORDERS AND PRODUCTION LEVEL



Factory snarls due to these fluctuations occasionally caused the factory to miss deadlines. These in turn led on occasion to warehouse delays in filling branch orders, and forced the branches to hold to the two-week delivery time even though actual transit time was only one week. An analysis revealed the following:

Factory fluctuations were very costly. A statistical regression of costs against operating levels and changes showed that annual production costs were affected more by the average *size* of changes in level than by the frequency of change; a few large changes in operating level were much more costly than many small changes.

Under the "economical reorder quantity" system, production fluctuations were no larger than before, but the average change up or down actually equaled 80% of the average production level. This was estimated to cost $11,500 annually, bringing the total cost of the system, including costs of holding inventories, placing orders, and changing production rates, to $17,280 per year.

This led to the suggestion that the company try a new scheme so that orders on the factory warehouse and the factory would be more regular. A system with a fixed reorder cycle or period was devised, under which branch warehouses would place orders at fixed intervals, the order being for the amount sold in the period just ended. The factory warehouse would ship the replenishment supply, order an equivalent amount from the factory, and receive the order within two weeks or by the beginning of the next review period, whichever was longer.

Under this scheme, each branch warehouse would need to keep its stock on hand or on order sufficient to fill maximum reasonable demand during one review period plus delivery time (tentatively taken as two weeks) on the basis of the reorder rule described previously in this article. The question to be determined was: How long should the review period, that is, the time between reorders, be? EXHIBIT IX summarizes inventories and costs for reorder intervals ranging from one to six weeks, based on the following facts and figures:

1. *Branch safety stock* was determined from a study of branch sales fluctuations, to allow for maximum reasonable demand over the reorder interval plus the two-week delivery period.

"Maximum reasonable demand" was defined to allow a 0.25% risk of being out of stock in any one week (equal to the 1% risk on the average four-week interval under the "economical reorder quantity" system described previously).

2. *Branch cycle stock* would average one-half of an average shipment. Under this system, the average shipment to a branch each period would equal the average sales by the branch in one period (25 units × number of weeks).

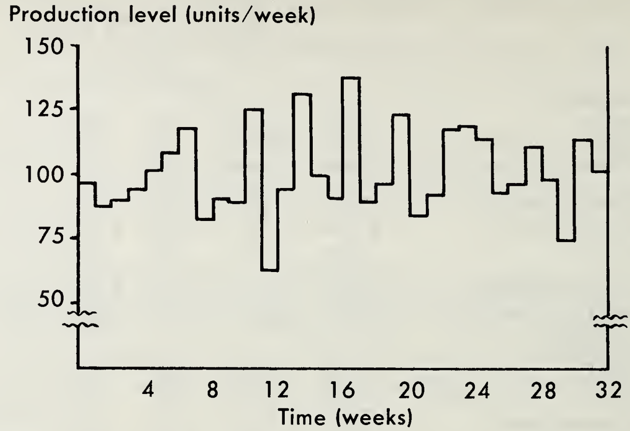
EXHIBIT IX. SUMMARY OF REORDER PERIOD COST COMPARISONS

	Length of period (weeks)					
	1	*2*	*3*	*4*	*5*	*6*
Branch warehouse						
Safety stock	24.0	26.0	27.0	28.0	30.0	31.0
Cycle stock	12.5	25.0	37.5	50.0	62.5	75.0
Transit stock	25.0	25.0	25.0	25.0	25.0	25.0
Total units of stock	61.5	76.0	89.5	103.0	117.5	131.0
Annual inventory cost	$ 310	$ 380	$ 450	$ 515	$ 590	$ 650
Ordering cost	990	495	330	250	195	165
Total cost each branch	$1,300	$ 875	$ 780	$ 765	$ 785	$ 815
Total cost four branches	$5,200	$3,500	$3,120	$3,060	$3,140	$3,260
Factory warehouse						
Safety stock	33	33	41	47	52	58
Cycle stock	50	100	150	200	250	300
Total units of stock	83	133	191	247	302	358
Annual inventory cost	$ 290	$ 465	$ 670	$ 865	$1,060	$1,250
Ordering cost	700	350	235	175	140	120
Total cost factory	$ 990	$ 815	$ 905	$1,040	$1,200	$1,370
Production change costs	$1,600	$2,250	$2,760	$3,180	$3,560	$3,900
Total system costs	$7,790	$6,565	$6,785	$7,280	$7,900	$8,530

3. *Transit stock* equaled one week's sales.
4. *Branch inventory carrying cost* was $5 per unit per year.
5. *Branch ordering costs* equaled $19 per order, with one order per period. A one-week period would mean 52 orders per year; a two-week period, 26 orders per year; etc.
6. *Factory safety stock* was set to allow a 1% risk that the warehouse would be unable to replenish all branch shipments immediately.
7. *Factory cycle stock* in process or in the warehouse would be approximately equal to one-half the sales in any one period.
8. *Factory inventory carrying cost* was $3.50 per unit per year.
9. *Factory ordering costs* equaled $13.50 per order (see 5 above).
10. *Production change costs* were proportional to the period-to-period changes in production level, equal under this system to period-to-period changes in branch sales.

The figures show that a two-week reorder interval would be most economical for the company as a whole, and this was chosen. Costs were estimated to be $6,600, compared with $17,300 under the "economical reorder quantity" system. While the new system cut total inventories by nearly 70%, most of the gain came from smoother production operations. EXHIBIT X shows weekly production for a representative period under the new system.

EXHIBIT X. PRODUCTION FLUCTUATIONS REDUCED WITH FIXED REORDER CYCLE



Further economies became apparent when the system was in operation:

1. The reduction in production fluctuations made it possible to meet production deadlines regularly, cutting the effective lead time in deliveries to branches and thereby permitting modest reductions in branch safety stocks.

2. The inventory system was found well suited to "open" production orders. Instead of issuing a new order with each run, the moderate fluctuations made it possible to replace production orders with simplified "adjusting memos" and at the same time to eliminate much of the machine setups.

"BASE STOCK" SYSTEM

The success with the periodic reordering system encouraged the company to go further and try the "base stock" system referred to earlier. Under this system, the branch warehouses would *report* sales periodically. The factory would consolidate these and put an equivalent amount into production. Stocks at any branch would be replenished whenever reported sales totaled an economical shipping quantity.

Two possible advantages of this system compared to the fixed period scheme were: (1) Branches might be able to justify weekly sales reports, reducing production fluctuations and safety stock needs still further. (2) It might be possible to make less frequent shipments from factory to branches and make further savings. The following questions had to be decided:

How frequently should branches report sales? As noted earlier, cost studies showed that of the $19 total cost of ordering and receiving goods $6 represented clerical costs in placing and recording the order. Here is a summary of the costs affected by the choice of reporting interval:

	Reporting interval			
	One week		Two weeks	
	Number	Cost	Number	Cost
Branch safety stock	100	$ 500	108	$ 540
Production changes		1,600		2,250
Branch clerical costs	4 × 52	1,250	4 × 26	625
Total		$3,350		$3,415

Thus, there appeared to be some advantage to reporting sales weekly from branches to the factory.

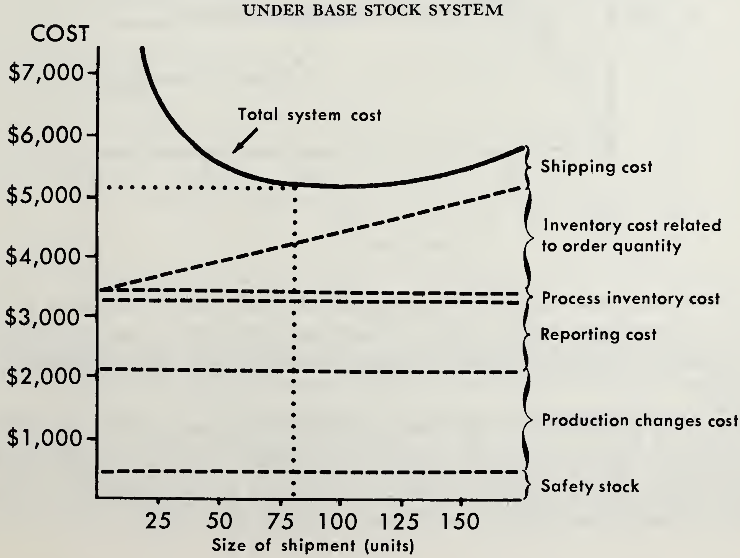
How big should replenishment shipments be? EXHIBIT XI summarizes the system costs related to the size of shipment from factory to branch. Each line shows the total of the cost indicated plus those represented by the line below. The total system cost (top line) is lowest at 82; that point is therefore the optimum shipping quantity from factory to branch warehouse. The same answer can be obtained from the formula given before, $\sqrt{2 \cdot \$13 \cdot 1{,}300/\$5} = 82$.

The base stock system therefore was set up with weekly reporting and replenishment shipments of 82 units to branches. The total cost of the base stock system was $5,200 compared with $6,600 under the previous system.

STABILIZED FURTHER

The company, cheered by its successes, decided to see if even further improvements might be obtained by cutting down further on production

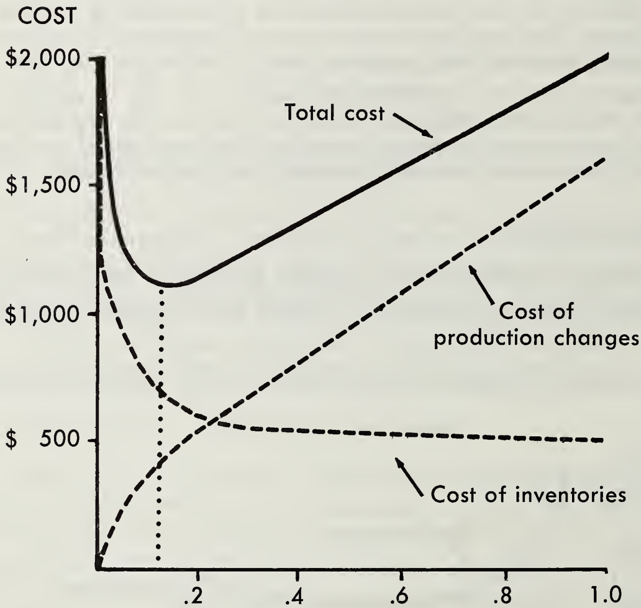
EXHIBIT XI. OPTIMUM SHIPPING QUANTITY FROM FACTORY TO BRANCH WAREHOUSE UNDER BASE STOCK SYSTEM



fluctuations. As it was, the production level under the base stock system was being adjusted each week to account for the full excess or deficiency in inventory due to sales fluctuations. It was proposed that production be adjusted to take up only a fraction of the difference between actual and desired stocks, with added inventories used to make up the difference.

The possibilities were analyzed along the lines described previously in the text; the results are summarized in EXHIBIT XII. The two costs that would

EXHIBIT XII. COST OF PRODUCTION CHANGES AND SAFETY STOCK VS. RATE OF RESPONSE TO SALES FLUCTUATIONS



be affected are costs of changing production and costs of holding inventories, in particular safety stocks. These are affected by the fraction of the inventory departure that is made up each week by adjusting production.

The study showed that the cost would be minimized with the rate of response set equal to 0.125, as seen in the exhibit. (This compared with a response rate of 1.0 under the base stock system.) The additional savings of $970 brought the annual cost of the system down to $4,200.

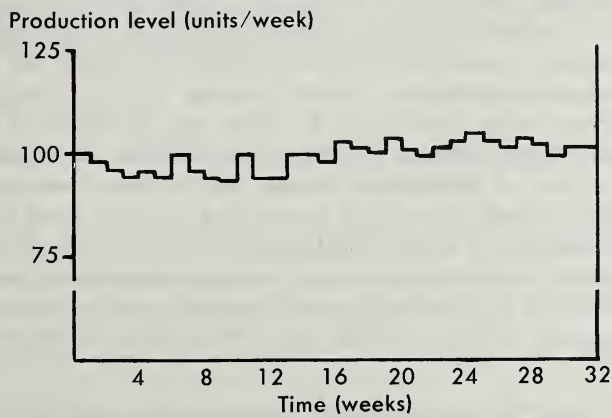
SUMMARY

The results of all the changes made by the division management were substantial:

1. *A major reduction in stocks*—They had been cut 35% from what they were even with the "economical reorder quantity" system.
2. *A substantial reduction in production fluctuations*—EXHIBIT XIII shows what weekly production levels for a typical period looked like at the end, contrasted with EXHIBITS VIII and X for the same sales.

The problems of the case are common even among the best-run businesses and can be solved in much the same way with much the same results. Of course, a large part of the effort and expense that were necessary in this step-by-step, evolutionary approach could be saved. Technical methods are available for analyzing and measuring the performance of alternate systems so that management can proceed directly to the ultimate

EXHIBIT XIII. PRODUCTION LEVEL UNDER THE BASE STOCK SYSTEM WITH A REACTION RATE OF 0.125



system that is most desirable; management does not have to feel its way. Let me emphasize again, however, that no one kind of system should be considered "the goal." The efficiency of any given inventory control plan depends too much on the demand and cost characteristics of the business.

In the discussion thus far, several large questions remain unanswered. What happens when the business is subject to seasonal sales? What more

can be done than to insure that desired levels of service are maintained while cutting inventory and production costs? Where do forecasting and scheduling fit into the picture? I shall discuss these questions in the next and final article in this series.

26. GUIDES TO INVENTORY POLICY III. ANTICIPATING FUTURE NEEDS

John F. Magee*

Mr. John F. Magee concludes the series of articles by discussing the crash, seasonal and similar problems as they affect a rational program of inventory and production. Planning, with its major problem of forecasting, and control are included in the total approach to the inventory-related aspects of business.

Businessmen are prone to view inventories with distaste, as an apparently necessary drain on resources, something that no one has been able to eliminate but hardly a "productive" asset like a new machine or tool. In fact, however, inventories are as productive of earnings as other types of capital investment. They serve as the lubrication and springing for a production-distribution system, keeping it from burning out or breaking down under external shocks. They help to absorb the effects of errors in forecasting demand, to permit more effective use of facilities and staff in the face of fluctuations in sales, and to isolate one part of the system from the next in order to permit each to work more effectively.

In this article let us look at the function of a third type of inventory, one which is of particular importance in long-range planning: anticipation stocks. This type of inventory is most commonly needed where sales are highly seasonal, and where either one or the other of these problems occurs:

1. The "crash" or short-peak season problem which arises, for example, in the toy industry before Christmas or in certain fashion clothing lines at various times during the year.
2. The more conventional seasonal problem arising in industries where sales show a pronounced seasonal swing, with the peak season often extending over several weeks or months, as in the case of automobiles, many kinds of building materials, certain cosmetics, some types of home appliances, agricultural supplies, and furniture.

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* From *Harvard Business Review,* XXXIV, 3 (1956), 57-70. Reprinted by permission of the *Harvard Business Review.*

Stocks built up to buffer production against seasonal fluctuations in sales are not the only form of anticipation stocks. Anticipation stocks may also be carried, for example, to meet a planned intensive sales campaign or to carry sales over a plant vacation or maintenance shutdown. However, the questions and methods of attack which apply to seasonally fluctuating sales also illustrate approaches to control of other types of anticipation stocks; I shall therefore use the former as a basis of discussion in this article.

THE "CRASH" PROBLEM

In the "crash" type of problem, management must balance the risks of not having enough stocks to fill demand and thus losing profit, or of being forced to go to extraordinary measures to buy or produce to fill demand, against the risks of having too much on hand and consequently incurring sizable write-off and obsolescence loss or storage expense until the next selling season.

The question boils down to how much stock to have on hand when the main selling season opens. The objective basically is to have enough on hand so that the company can expect, on the average, to break even on the last unit produced; that is, to carry enough so that on the last unit the expected risk of loss due to inability to fill demand equals the expected cost of carrying the unit through to the next season.

METHOD OF APPROACH

In principle, the solution to the "crash" problem is quite simple. The classic "newsboy" case is as good an illustration as any:

A newsboy has, on the average, 10 customers a night who are willing to buy papers costing 5¢ each. The newsboy makes a profit of 3¢ on each paper he sells, and loses 1¢ on each paper he takes out but fails to sell. Let us suppose he has kept records, and that 40% of the time he can sell at least 10 papers and 20% of the time he can sell at least 12 papers.

If the newsboy does not know how many papers he will actually sell in any given day but every days takes out 10 papers, he has a 40% chance of selling all the papers and making 3¢ each, and a 60% chance of not selling all papers and losing 1¢ on each not sold. He can expect the tenth paper to produce, on the average over time, a profit of 0.6¢ (3¢ × 40% − 1¢ × 60%). On the other hand, if he takes 12 papers every night, he can expect the twelfth paper to produce, on the average over time, a loss of 0.2¢ (3¢ × 20% − 1¢ × 80%).

It would not, therefore, be worth his while to take out 12 papers. As a matter of fact, he would probably make the greatest total profit by taking 11 regularly, since he could expect, on the average over time, to do slightly better than break even on the eleventh paper (3¢ × 30% − 1¢ × 70%, or 0.2¢). (See also p. 294.)

The newsboy problem is, after all, not so different from many business problems. Certainly from the newsboy's point of view the papers he buys which he may not sell represent a lot of money and a sizable risk of his capital. Indeed, perhaps the most important difference between the newsboy and businessmen in other situations is that the newsboy has to make this decision very frequently and therefore has more of a chance to build up a lot of experience on which to base intuitive judgments—that is, less need for careful calculation or formal statistical methods to wring out of past experience the information which is of value.

REACHING A SOLUTION

Suppose, for example, you are selling cosmetics and you want to make up a special Christmas package in a holiday wrapping containing three normally separate items at a combined price. You have tried a number of deals of this type in the past, and on the whole they have been highly profitable. However, individually they have been unpredictable; some have been very successful, and some that seemed excellent on paper turned out to be failures.

Your market research manager makes a volume prediction each time; on the average, his estimates come fairly close, but rarely on the nose. About half the time they are too high and half the time too low. In fact, 25% of the time your experience shows his estimate to be 20% or more on the high side, and just as frequently he misses as badly in the other direction. About 10% of the time he is as much as 40% off in each direction, and occasionally he really misses and actual sales are 75% or more off from the estimate. You are doing everything you can to improve these estimates, but in the meantime you have to decide how much to make up for your Christmas deal.

Cost estimates indicate that if a package is not sold, the items can be repackaged at an extra cost of about $1 per package. If demand exceeds the original run, the extra cost of a special rerun plus emergency shipments to field stocks is estimated to be $1.75 per package. Following reasoning like that in EXHIBIT I (simply a generalized expression in mathematical terms of the solution to the newsboy case), you or your operations research analyst concludes that you should plan initially to have enough stock so that the chance that demand, as it materializes, will be covered by the initial run equals the ratio of the special makeup cost to the total of (a) special makeup cost plus (b) repackaging loss on unsold items. In other words, you want to make enough so that the chance that total sales will be covered by the initial run equals $1.75 ÷ ($1.00 + $1.75), or 64%. With your past experience on forecasting success, this means about a 10% overstock; that is, your initial run should exceed your estimated needs by about 10%.

This will not eliminate all the difficulties by any means. There is nearly a 40% chance you will have to make some additional high-cost stock, and

EXHIBIT I. GENERALIZED MATHEMATICAL EXPRESSION OF APPROACH TO "CRASH" PROBLEM

Let:

V = volume of demand

$f(V)$ = the probability density function of demand (i.e., distribution of demand during one period)

$\int_Y^\infty f(V)dV$ = the likelihood of selling an amount Y or more during a season

n = the variable cost of making and holding a unit of stock in inventory during the selling period, including the capital charge for inventory investment, etc.

m = the profit per unit sold

L = the cost per unit of not filling an order (loss of good will), over and above the loss of profit

P = the cost of carrying a unit of inventory if unsold by the end of the period

K = the size of the inventory on hand at the beginning of the season

Then the profit earned during the replenishment cycle is given by:

$$\begin{aligned} p &= mV - P(K - V) - nK;\ V \leq K \\ &= mK - L(V - K) - nK;\ V > K \end{aligned}$$

and the expected profit earned during the replenishment cycle, $E(p)$, is given by:

$$\begin{aligned} E(p) = m\int_0^K Vf(V)dV - nK + mK\int_K^\infty f(V)dV - \\ L\int_K^\infty (V - K)f(V)dV - P\int_0^K (K - V)f(V)dV \end{aligned}$$

Again, differentiating the expected profit with respect to the inventory on hand at the beginning of the season, K, yields:

$$\frac{dE(p)}{dK} = -n + (m + L) - (M + L + P)\int_0^K f(V)dV$$

The maximum profit will be earned when $dE(p)/dK = 0$; that is, when

$$\int_0^K f(V)dV = \frac{m + L - n}{m + L + P}$$

there is still a good chance you will have unsold goods on hand after the holiday. However, this initial decision is about the best you can do with

present forecasting and manufacturing methods to get the right balance between the two risks and thus minimize the over-all cost.

In problems like those noted above, the costs may, superficially at least, look different, and the mathematical details of formulating an approach to the problem and arriving at an answer may differ, but the basic elements are the same—balancing the costs and lost profit opportunities of demand exceeding available stock against the costs and losses of having available unused stock or capacity.

DEVELOPING APPROACH

Sometimes from the scanty experience gained in early-season selling enough information can be developed so that estimates of total season sales and resulting production plans can be adjusted. As more and better information becomes available, mathematical methods can be used to alter the "strategy" for the season slowly, according to predetermined rules. Such a "developing" approach to inventory problems rests on the basic premises that one does not know the future, that there is therefore no need to plan into it very far in great detail, and that a good strategy for the present is one which puts you in a position to make a good choice the next time you have a chance, whatever actual experience may develop in the meantime. Applications of this general line of approach to problems are beginning to be made in the planning of heating-oil production, seasonal clothing production, and other seasonal, erratic demand problems.

SEASONAL SWINGS

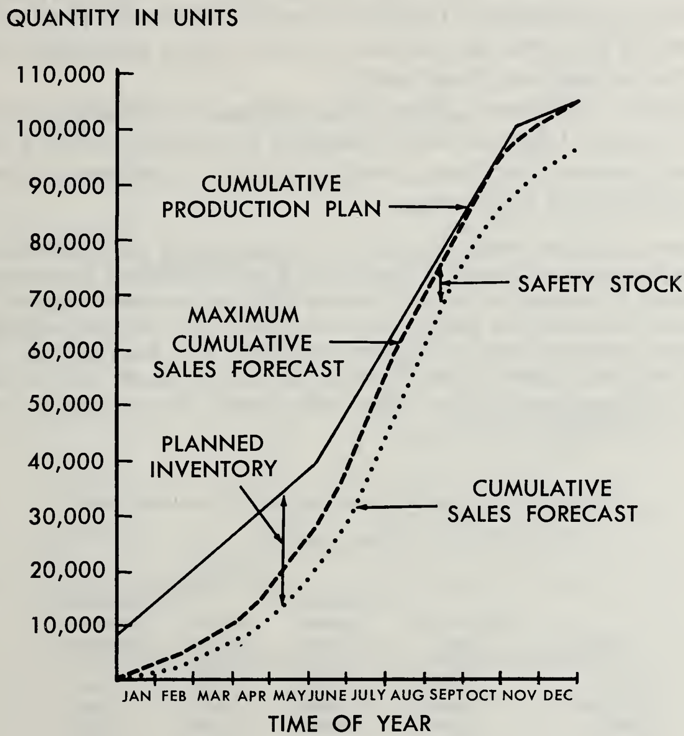
In many industries, the basic yearly pattern of seasonal sales may be quite predictable, and the over-all volume can be reasonably well estimated. There may be only a small error of a few percentage points in estimating either the total volume or the size of the peak. In situations of this sort there are three problems:

1. Adjusting the forecast of expected sales to allow for safety stocks so as to protect against forecast errors. (Examples of an original and an adjusted "maximum" sales forecast are shown in EXHIBIT II. The latter is the original cumulative forecast increased by the safety stock allowance.)
2. Laying out a production pattern or plan to meet the forecast. (The difference between forecast and production plan will result in a planned inventory as illustrated in EXHIBIT II. The total costs of inventory and production depend on the form of the production curve, and characteristically the object is to choose this curve or production plan to minimize the expected total of these costs.)
3. Controlling or adjusting the production plan to keep it aligned with the sales forecast, as actual sales experience modifies the forecast and/or results in depleted or excessive inventory as compared with the plan.

MEETING FORECAST ERRORS

The answer to the first problem depends somewhat on that for the third, as the discussion on production control rules in the second article in this series may suggest. In general, however, it is fair to say that in most businesses the risks and costs of back orders so outweigh inventory cost that substantial protection in the form of safety stocks is justified. These safety stocks must be large enough so that stocks can be restored after a

EXHIBIT II. ILLUSTRATIVE SALES FORECAST AND PRODUCTION AND INVENTORY PLAN



sudden unexpected sales spurt by a smooth and moderate adjustment in production rate. The production response rules described in the previous article, which take into account the nature of forecast errors, inventory costs, and service requirements, are one way of determining what is "large enough."

Another very similar approach is to begin with a forecast of maximum expected demand, or maximum demand the company is prepared to plan for. The long-range production plan is made out to meet this directly. Then production is adjusted downward from plan as excess inventories accumulate because of actual sales falling below the maximum plan. (More will be said later about this problem of production control.)

PLANNING PRODUCTION

Once the adjusted sales forecast or forecast plus safety stock has been obtained, the task is to plan the production rate or draw in the production curve shown in EXHIBIT II. The problem is to find a curve or mathematical function that will minimize the total of production and inventory costs. In theory, this sounds like a straightforward mathematical problem often encountered in physics. In practice, the job is not so easy, but a number of techniques have been found useful.

Graphical Techniques. Where the problem of planning production against forecasted seasonal sales is not made too complicated by a variety of items, processes, and stages, simple graphical or arithmetic techniques can often be useful. For example:

Suppose a company has a forecast at the beginning of the year which calls for requirements as outlined in EXHIBIT III. The first column shows expected sales month by month; the second column shows accumulated expected sales; the third column shows a safety reserve to cushion the company against forecast errors, allowing time for smooth adjustment (the basis for this reserve will be discussed further below); and the last column shows the total amount that must be produced by the end of each month, allowing for an opening stock of 3,500 units.

EXHIBIT III. FORECAST OF SALES AND SAFETY STOCKS NEEDED

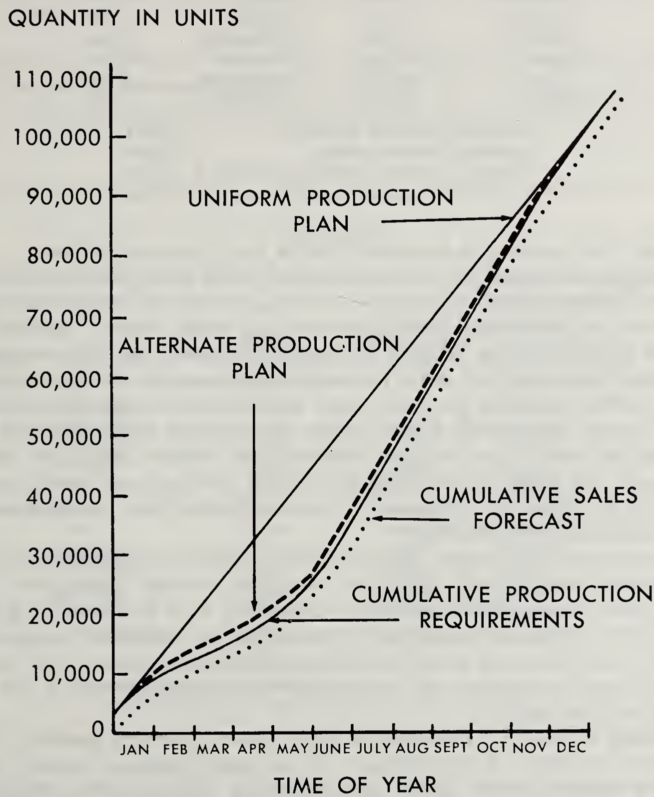
(In units)

Month	*Expected sales*	*Cumulative sales forecast*	*Safety reserve*	*Cumulative total requirements**
January	6,000	6,000	3,000	5,500
February	4,000	10,000	2,500	9,000
March	3,000	13,000	2,100	11,600
April	4,000	17,000	2,500	16,000
May	6,000	23,000	3,000	22,500
June	9,000	32,000	3,500	32,000
July	11,000	43,000	4,000	43,500
August	12,000	55,000	4,200	55,700
September	13,000	68,000	4,400	68,900
October	12,000	80,000	4,200	80,700
November	11,000	91,000	4,000	91,500
December	9,000	100,000	3,500	100,000

* Less opening stock of 3,500

The cumulative forecast and cumulative requirements, including opening stock, are shown in EXHIBIT IV. The company *could* produce at an average annual rate of 100,000 units, or 8,333 units per month—the production plan shown as a straight line in the exhibit. This plan would produce just enough inventory at the end-of-year peak to meet requirements. The month-end inventories (equal to the difference between the production plan and the cumulative sales forecast) are shown in EXHIBIT V. They average 12,800 units, of

EXHIBIT IV. CUMULATIVE SALES FORECAST AND ALTERNATE PRODUCTION PLAN



which 3,400 are accounted for as safety stock, leaving an average seasonal anticipation stock of 9,400 units. If the annual inventory carrying cost were $45 per unit, the seasonal anticipation stocks would be costing about $425,000 per year.

Various alternatives might be tried to reduce this cost. For example, operations might be run during the low months of the year at the rate of 4,000

units per month, building up to a peak rate of over 13,000 units per month in September. This plan, shown by the dashed line segments in EXHIBIT IV, would result in substantially lower anticipation stocks. The average inventory would be 3,700 units, with 3,400 units safety stock, or 300 units seasonal anticipation stock. At $45 a unit, the cost of seasonal stock under this plan would be only

EXHIBIT V. MONTHLY ENDING INVENTORY

(In units)

January	5,830	July	18,830
February	10,170	August	15,170
March	15,500	September	10,500
April	19,830	October	6,830
May	22,170	November	4,170
June	21,500	December	3,500

Average monthly inventory	12,800
Average safety reserve	3,400
Average seasonal anticipation stock	9,400

$13,000 per year, a saving in inventory cost of over $400,000 per year.

The saving, of course, is not all net saving, since it is gained at the cost of adding and laying off the equivalent of some 9,200 units of production capacity. If this were, say, a chemical plant operating well under capacity and the variation from 4,000 to 13,200 units of production a month could be managed by adding and then laying off some 100 semiskilled men, the saving in inventory cost—equivalent to $4,000 per man hired and released—might well justify the change. On the other hand, if the change in operating levels involved adding and laying off some 1,000 to 1,500 employees of various skills, the inventory saving might fall short of offsetting the hiring, training, and layoff costs, not to speak of its effect on community relations. Under these circumstances, the change might not be worthwhile.

This alternative production plan, of course, calls for substantially increased plant capacity—nearly 60% more—for the same average throughput. If the capacity were not available and had to be added, or if it would be gained at the cost of overtime or second-shift premiums, or additional equipment installations, the simple cost calculation just outlined would have to be extended to include these extra costs and investments (not a difficult task if the procedures are well laid out).

By making similar trial calculations under other operating patterns, one can quickly get a picture of the influence of operating pattern on cost, and can arrive at a pattern which comes close to giving the minimum over-all cost. This plan then represents the basis for procurement, employment, and inventory control during the coming months until new forecasts call for an adjustment.

The operating plan summarized in EXHIBIT VI is essentially a minimum-cost plan, under the conditions that: (a) inventory costs are $45 per unit; (b) the cost of hiring and training an employee is $300 (typical of many industries); (c) a change of 750 units in the monthly rate of output requires employment or release of 100 men. The cost of seasonal inventory equals 2,150 units (average seasonal anticipation stocks) × $45 per unit, or about $97,000. The

plan calls for varying the production rate from a low of 5,000 units per month to a maximum of 11,000 units—a change of 6,000 units; this requires hiring and training 800 new employees at a cost of $240,000. (If the hiring and subsequent layoff of 800 employees is considered an undesirable employment variation, the solution must be sought within whatever are set as the feasible or tolerable levels.)

Thus, under the plan in EXHIBIT VI the total of seasonal anticipation inventory stocks and hiring and training costs is $337,000. This represents a net saving of nearly $90,000 per year compared either with the uniform production plan or the alternative plan in EXHIBIT IV. (With the hiring and training costs taken into account according to the conditions assumed for EXHIBIT VI, the alternative plan with its extreme employment variation comes out about the same as the uniform plan.)

Advanced Techniques. Sometimes the problem of planning production to meet seasonal demand is too complicated for simple graphical techniques, and more specialized techniques are needed. One of these is linear

EXHIBIT VI. MINIMUM OVER-ALL COST PLAN

(In units)

Month	*Sales forecast*	*Monthly production plan*	*End-of-month inventory (including safety reserve)*
January	6,000	5,500	3,000
February	4,000	5,000	4,000
March	3,000	5,000	6,000
April	4,000	5,000	7,000
May	6,000	5,200	6,200
June	9,000	11,000	8,200
July	11,000	11,000	8,200
August	12,000	11,000	7,200
September	13,000	11,000	5,200
October	12,000	11,000	4,200
November	11,000	10,800	4,000
December	9,000	8,500	3,500
Average monthly inventory			5,550
Average safety reserve			3,400
Average seasonal anticipation stock			2,150

programing. The problem just described *might* have been attacked by linear programing methods in order to cut through the repeated trials to a good solution, but this approach was not necessary because trial and error did not involve a prohibitive amount of time and effort. Linear programing has been found useful in circumstances where the problem is complicated, for instance, by one or more of these conditions:

Several product lines using the same facilities or staff.
Possibilities of planned use of overtime to meet peak needs.

Need for considering extra-shift premiums.

Several stages in manufacturing, with seasonal storage possibilities between.

A number of alternate plants, with different cost and employment situations, to meet demand.

Joint planning of plant operations and of the assignment of branch warehouses to the plant.

When the seasonal planning problem is attacked as a linear programing problem, the objective is to minimize the total of costs incurred in carrying inventories forward in slack periods to meet future sales peaks, changing the production level to meet sales requirements, or resorting to overtime. The objective has to be reached within the limitations imposed by: (a) capacity restrictions on the amount which can be produced at normal or overtime rates in any month; (b) the requirement that inventories in each line or product be planned large enough to meet sales requirements; and, possibly, (c) the amount of variation that can be tolerated in the planned production rate.

Illustrations of production planning problems formulated in linear programing terms can be found in technical literature on the subject.

CONTROLLING PRODUCTION

Once the production plan has been made, it and the sales forecast dictate a sequence of planned inventory balances. However, as sales experience accumulates, actual stocks will fall below or exceed the planned balances. The minimum inventory balance or safety stock which has been (or should have been) set up will absorb the immediate effects of departures of actual sales from forecast, but it will be necessary to keep adjusting production plans *periodically* to bring inventories into line. The size of the needed safety stock, it should be emphasized, depends on the way production adjustments are made.

The task is comparable to that of adjusting production in the face of demand fluctuations, described in the preceding article in this series. There it was pointed out that methods used generally take this form: adjusted production = original production plan (or forecast sales level) ± *some fraction* or part of the deficiency or excess of inventory compared with "normal" or "par." The idea is to keep adjusting production to bring inventory back into balance in the face of fluctuations in demand. If the fraction is large (close to one), production is made very responsive to sales fluctuations, and the inventory needed is smaller. If the fraction is small, the inventory acts to absorb sales fluctuations, and must be larger; production changes from original plan are smaller.

Production plans to meet seasonal sales have to be kept in adjustment in much the same way, and basically similar control systems can be used. In this case, the original plan is the production plan (e.g., EXHIBIT VI)

worked out to meet seasonal sales. The "normal" inventory is not a fixed level, as in the other case, but varies from month to month; it is the planned inventory of EXHIBIT VI, including the safety stock. The steps to take in planning production are these four:

1. From a study of forecast errors or possible differences between sales and forecast, and of costs of holding inventory and changing production, choose the desired fraction or rate of adjustment in production and the corresponding safety stock, using methods of the type described in the preceding article.

The choice of safety stock does not involve production levels, just the costs of changing production and holding stocks, along with anticipated forecast errors.

2. Add the safety stock so chosen to the cumulative sales forecast month by month to get the accumulated production required.
3. Plan production period by period to meet requirements, as described earlier.
4. Periodically adjust the planned production by the specified fraction (chosen in Step 1) of the departure of actual inventories from the plan for the period.

For those interested in the actual working through of a problem, EXHIBIT VII shows the mathematical expression of the production control rule.

RELATIVE IMPORTANCE

The relative importance of anticipation stocks and of lot size stocks and fluctuation stocks (described in the previous articles) will differ from case to case. A study of sales and production characteristics is basic in

EXHIBIT VII. PRODUCTION CONTROL RULE EXPRESSED MATHEMATICALLY

The rule can be written formally as:

$$\hat{P}_i = \overset{*}{P}_i \pm k(\overset{*}{I}_{i-1} - I_{i-1});\ 0 < k \leq 1$$

where:

$\hat{P}_i$ = adjusted production plan for period i

$\overset{*}{P}_i$ = original production plan for period i

$\overset{*}{I}_{i-1}$ = planned closing inventory for period $i - 1$

I_{i-1} = actual closing inventory for period $i - 1$

k = fraction of inventory departure adjusted for in production

$\overset{*}{P}_i$ and $\overset{*}{I}_i$ are chosen by the methods described earlier to minimize total inventory and operating costs and meet the production requirements:

$$R_i = F_i + S_i$$

where:

R_i = production required up through period i
F_i = accumulated forecast of sales through the period i
S_i = safety stock needed for period i

The safety stock, S_i for each period is in general proportional to expected forecast errors and related to the value of k that is chosen. Thus, if forecast errors from period to period are independent,

$$S_i = A\sqrt{\frac{1}{2k - k^2}}\,\sigma i$$

σi being the standard deviation of forecast errors for the period; and A a parameter which depends on the percentage of customer orders which management desires to fill directly from stock (typical values range from 1.3 to 2.5, corresponding to 90% and 99% protection).

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finding out what inventory functions are important, and what the significant costs and policies related to these functions happen to be.

SALES CHARACTERISTICS

Sales characteristics which strongly influence the production and inventory control system (and the relative importance of the different inventory functions) include:

1. *The unit of sales*—Are sales made in dozens, tons, or carloads? Planning must be done in terms of this characteristic unit. It is obviously not enough, for example, to have several tons on hand if the usual unit required is a carload.
2. *The size and frequency of orders*—Are there a few large orders each day or week, or a steady stream of small orders? This is related to the question of unit of sales, but the same total volume sold in a large number of small orders can characteristically be supported by substantially less inventory than if sold in a few large orders, unless special measures are taken to reduce the uncertainty about the time when individual large orders will be placed.
3. *Uniformity or predictability of sales*—Do sales show predictable seasonal fluctuations? Or do they show large short-term fluctuations, uncontrollable or self-imposed (as by special sales campaigns)? Handling large, unpredictable fluctuations requires flexibility and additional capacity in inventory production as well as carefully designed rules for adjusting or controlling inventory balances. But where fluctuations are predictable, advance planning techniques can be used.
4. *Service requirements or allowable delay in filling orders*—Where allowable delays are small, inventories and production capacity must be correspondingly greater; care is required to be sure the control system is really responsive to needs.
5. *The distribution pattern*—Do shipments go direct from factory to customer, through field warehouses, through jobbers, retailers, or consignment? The more stages there are, characteristically, the more inventory is required. Field inventories in fact serve basically to improve service to jobbers or retailers and thereby to remove from them some of the burden of keeping stocks.

Where the product moves through several stages of handling from factory to ultimate consumer, prompt reports or estimates of movement, as close to the consumer level as possible, are important in minimizing the amount of uncontrollable fluctuation in demand which the factory has to contend with. Often the reordering habits of retailers and jobbers can seriously exaggerate the basic uncertainty in consumer demand for a product, and thereby compound the inventory and production control problems of the plant.

6. *The accuracy, frequency, and detail of sales forecasts.*—Fluctuation stocks exist basically because forecasts are not exact. Thus the inventory problems of a business are directly related to its inability to forecast sales with precision. This does not mean that lack of precise sales forecasts is an excuse for sloppy control. Sometimes it is more economical to accept the forecasting uncertainties and stick to the plan, whether it means overproduction or underproduction, than to pay the price in inventories or production fluctuations. But the responsibility of forecast errors for inventory needs should be clearly recognized, and the control system should be adapted to the type of forecasts that are possible.

PRODUCTION CHARACTERISTICS

The production characteristics which influence the scheme of production and inventory control are:

1. *The form of production organization*—Job-shop type organization is an expensive way of getting flexibility; a company using it should be sure it really needs that degree of flexibility. The inventory and production control scheme can be considerably simpler under a product-line organization than in a job shop.

2. *The number of manufacturing stages*—Where a number of stages in manufacturing exist, the inventory control scheme must be set up to take advantage of differences in cost and obsolescence risk which are likely to exist.

3. *The degree of specialization of the product at specific stages*—Is each end product distinct from the raw material stage on, or are the different products more or less the same up to the final processing, assembly, and packaging? Where the latter is true, economies are often possible in keeping the right balance of stocks in the semifinished state and by simplifying the control and scheduling of preliminary stages where the types of product are not diverse.

4. *Physically required processing times at each stage*—Processing times affect the length of delay, after issuing a replenishment order or adjusting a production rate, before the action becomes effective. The length of this delay, in turn, directly influences the size of the inventory needed.

5. *Capacity of production and warehousing stages*—Capacity obviously affects the size and frequency of reorder.

6. *Production flexibility*—How rapidly can management vary production rates, shift personnel among product lines or departments, and change equipment from one product to another? Management of inventories and production control are basically a question of striking a balance among production flexibility and capacity, inventory levels, and customer service needs. No company is free to pick all three at will. A realistic inventory control system must be set up to recognize the limitations in flexibility which exist.

7. *Kind of processing*—Are batches of materials of a certain size needed in production? If so, the quantities and combinations must obviously be taken into account in scheduling for production.
8. *Quality requirements, shelf-life limits, or obsolescence risks*—These set important upper limits on the extent inventories can be used to buy flexibility and free production operations from fluctuations in demand.

These sales and production characteristics cannot be readily distinguished as having one type of effect or another on the production planning and inventory control scheme. Nor is it true that one type of characteristic dictates one approach while another kind of product always requires something else. However, the job of setting up a sound production and inventory control system is not just a job of setting up the right clerical routines and staff organization; it is a research job to find out how the product sales and production characteristics can be exploited to get an economical balance between production flexibility, inventory investment, and customer service.

ROLE OF FORECASTING

The need for estimates of future sales to control inventories is clearest in the case of anticipation stocks, but it exists in the case of the other functions as well. Whether forecasts are needed or possible is not the question; they are made formally or informally every time a decision is made whether to build or replenish an inventory. The question is whether the necessary forecasts are being made as well as they might be if formally recognized and if available statistical and market research techniques were used. Without going into the methods of forecasting, which is a considerable subject of its own, the following points are significant here:

Economical inventory plans depend on realistic estimates of need—not just sales goals or quotas. Even so, there are bound to be forecasting errors—and the bigger the possible errors, the bigger the inventories must be to guard against them.

A single forecast figure, without specifying the estimated error or limits of error, is not enough. Sometimes the need may be met by a maximum sale forecast indicating the upper limit of demand which the production or distribution organization will be required to service.

To estimate the limits of error requires a comparison of past forecasts and sales—and often this is hard to do, either because the earlier forecasts were made informally, or the records were discarded and hopefully forgotten.

In any event, forecasting errors bear so importantly on inventory economy that to keep the control system up to date requires systematic review of past errors and effort to improve the forecasting method.

PRODUCTION SCHEDULING

The task of translating inventory policy into practice, of reacting to demand as it materializes and utilizing the inventory balances and planned production capacity, is a function of production scheduling. Considerable effort has gone into the development of techniques—board displays, filing systems, card systems, and so on—to facilitate scheduling and control of progress on orders scheduled. These techniques can be extremely useful *if* they are adapted to the nature of the product and manufacturing facilities and *if* they are used in a framework of self-consistent inventory balances and production operating levels. The essence of the control problem is setting this framework in the light of management policy, not making the actual schedules.

Conventional scheduling methods are often worked out to cope with the complexities of job-shop production, where each order is unique and no set sequence of operations exists.

Scheduling operations in this way through a large number of stages or departments is difficult. Fortunately, however, the need for so doing is not nearly so common as one might gather. Many businessmen, in discussing inventory and production control, give the impression that their organization with its large product line—whether several hundred or several tens of thousands—is saddled with job-shop operations from top to bottom. They look with longing toward the lower operating costs and simpler management problems of assembly-line operations. They frequently fail to recognize that almost all products and product lines are capable of being manufactured under a wide range of organizational forms intermediate to the extremes of either pure job-shop or assembly-line operation.

Taking advantage of this latitude has been a source of considerable operating economy in some businesses—and could be in many more.

CONTROL SYSTEMS

A comprehensive inventory control system should be closely co-ordinated with other planning and control activities, such as sales forecasting, cash planning, and capital budgeting, since it affects all of these activities in many ways. The specific steps and timing will vary from one company to another, depending on product and process requirements, but the essentials of an inventory control system can be grouped into three broad classes: long-range inventory planning, short-range planning, and scheduling.

EXHIBIT VIII. SCHEMATIC DIAGRAM OF INVENTORY PLANNING

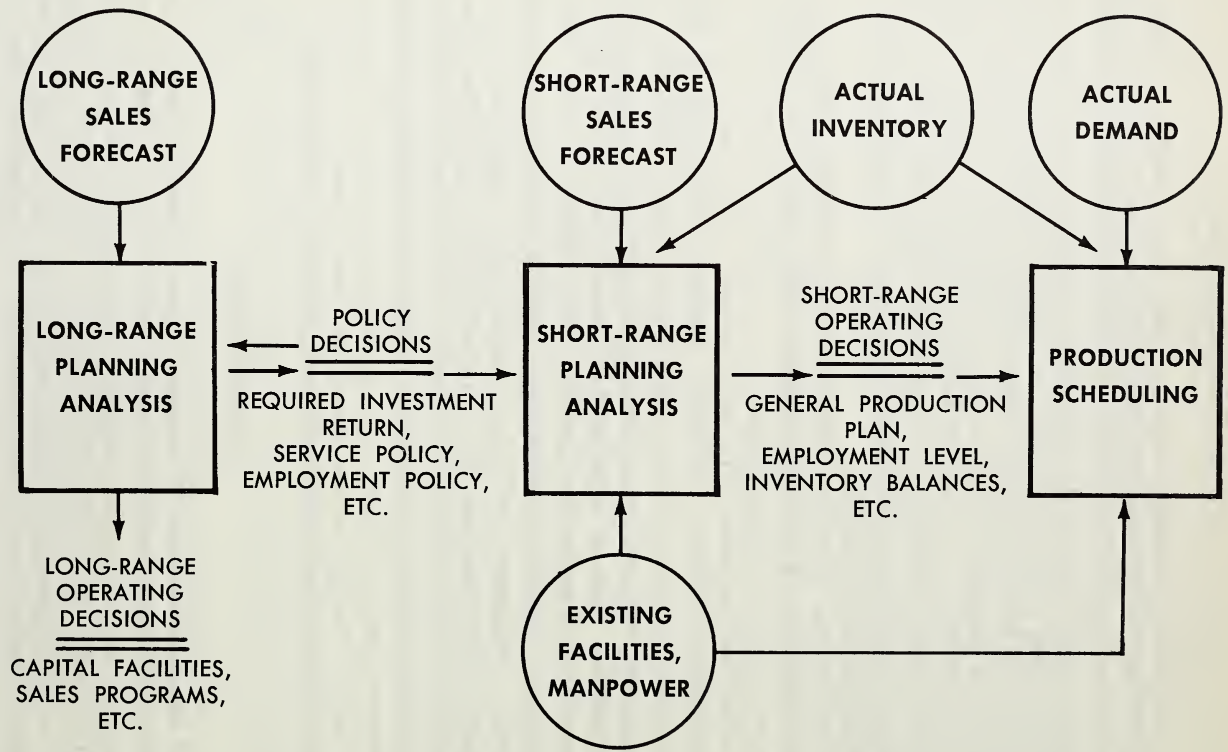

EXHIBIT VIII shows the three basic planning functions in boxes, with the arrows indicating the flow of information to and from the analysis. More specifically:

1. The *long-range* plan makes use of: (a) sales forecasts, with error or range estimates, and (b) preliminary policy decisions on capital allocation and value and on the amount of risk to be assumed. The purpose is to show the implications of policy choices so they can be refined and sharpened, and then to provide a basis for long-range operating decisions concerning construction, purchase, and sale of facilities, adjustment of sales and promotion programs, and so on. The analysis results may also lead to further forecasting effort by showing the production and capital costs resulting from poor forecasts.

2. At the intermediate stage, the *short-range* plan uses as its "raw materials" or inputs: (a) the results of policy decisions, (b) short-term demand forecasts, (c) existing facilities and manpower, and (d) inventories. The outputs are bases for short-range operating decisions—the general production plan to follow, adjustments in the employment rate, corrections in inventory balances.

3. Finally, within this framework *scheduling* can react to demand as it actually materializes.

VII

RESEARCH AND DEVELOPMENT AND THE ADMINISTRATOR

27. CONTROLLING THE COSTS OF RESEARCH

Edward P. Burnham*

Mr. Burnham gives a step by step program for assuring a uniform and realistic gathering of data for research program and cost analysis.

THE PURPOSE OF RESEARCH

Ralph H. Manley has defined the purpose of research in terms of a responsibility of management "to provide the technical leadership necessary in order for the company to earn a satisfactory return on its invested capital, both this year and especially down through the years to come."

Restated as objectives, this responsibility becomes:

1. To maintain the company's prestige and profits by keeping existing products competitive in quality and price.
2. To improve the company's competitive position and increase profits by developing new products that replace or supplement existing products, and by improving present products to a point where they have greater acceptability in the market.

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* From *The Management Review*, XLVII, 8 (1958), 20-24, 80-83. Reprinted by permission of the *American Management Association, Inc.* and *The Management Review*.

3. To explore possibilities for expansion into related or unrelated fields that offer opportunity for substantial profits.

If we accept these as the objectives of research, then we have a charter for the establishment of budgets and cost reports, which in turn will provide data for control of research by management.

DEFINING RESEARCH COSTS

Costs must be measured on a consistent and well-defined basis before they can provide meaningful data for management decisions. This requires a clear understanding of what is to be included in—and excluded from—research costs.

Fundamental research should be included, since it covers work leading to new technology, even though it has no particular connection with present products. In addition, projects leading to entirely new products or processes should be included when they are within the broad scope of the company's present field of activity. And finally, projects should be included when through application of new technology, they lead to improvement of present products and processes, or when they are designed to protect current investment and market position.

At the same time, some items seem to find their way into the research budget even though they do not belong there. Examples of this kind of cost include technical advice or assistance to help the production department out of difficulty or to carry on its normal operations; trouble-shooting to correct production errors that have reduced normal standards of materials; cost-reduction activities for the production department; technical advice or service to the marketing department on specific customer problems; assistance to the marketing department in the extension of going products into new application areas; and preparation of samples, at marketing department request, for specific customer requirements.

Since the research department must account for and justify its expenditures in terms of results, it should only be charged with the costs of research activities. All work of a service nature should be charged to the department for which it is performed, and the accounting system should include a method for separating these costs from research costs. The extent of the research department's service effort should be measured by the availability of research personnel to perform these services and still fulfill the research mission.

We must also decide when research responsibility—and therefore research cost—ends. Depending on established policies, any one of the following guides can be used:

When production accepts the process.
When commercial sale begins.

When the product is made in interim facilities.
When a pilot plant produces small quantities for sale.
When the product is turned over to the engineering department for commercial design.
When production drawings, a working model, and standard manufacturing practices are complete.
When the product has been manufactured long enough to show that it can be produced in quantity.
When the product is transferred to a manufacturing company or product division.

Nearly all research departments provide technical service for other departments, and some companies assign full responsibility for solving all problems of a technical nature to the research department. However, the majority of companies provide technical personnel in other departments—production, sales, engineering, etc.—to allow research personnel to concentrate their efforts on new products and processes.

When charges are made to other departments, they are accumulated under appropriate project numbers, and the total cost is transferred at periodic intervals from research accounts to the department requesting the service. The practice of making interdepartmental charges reflects their costs accurately and does not burden research with what properly should be manufacturing or sales expense. Furthermore, this practice requires that other departments justify their requests and discourages undue demands on the research department.

Interdepartmental charges are not made when it is established that the work is primarily research, when other departments might otherwise be duplicating existing projects, or when the company decides to minimize the expense of accounting for internal transactions.

DEVELOPING COST AND BUDGET REPORTS

Some large research departments have separated technical activities from administrative functions such as budgeting, accounting, and servicing. This permits research management and technical personnel to concentrate on research projects. When this approach is taken, the business administrator is usually a member of the research staff and reports directly to the director of research. He prepares budgets, assists in maintaining and improving the plan of control under the budgetary program, and guides or co-ordinates accounting reports.

When research departments are small, budgeting and accounting are normally performed by the accounting department. Regardless of organization, however, the director of research is responsible for financial plans embodied in the research budget.

The plan for classifying costs should meet management requirements at all levels, providing the necessary data from current accounting records.

The same classifications will, of course be used for budgeting as well as for recording current costs.

What does management want to know? If we consider managements requirements as questions, then our classifications system can be designed to answer them.

What was the total spent for research? This total can be obtained by having a single account to which all research expenses are charged. Since both the research director and top management are concerned with this type of data, it might be desirable to separate the expenses of different laboratories. The basic control account can remain the same, with the use of additional code numbers to identify each laboratory.

What was the cost of each individual project? When it has been decided to activate a particular research project, a project number is assigned and all expenses are charged to it. The research director and group leader can then determine the total expense for any project for a given period, thus measuring the research effort in terms of cost to the various projects.

What was the cost of the items making up the total expense? Normally, we can use the same expense elements, codes, and accounts that are assigned to other departments of the company, though some expenses peculiar to research will require special accounts.

Expense elements such as salaries, wages, supplies, depreciation, insurance, taxes, travel, and communications are common to all departments. However, items such as library, professional services, speakers, memberships, subscriptions, consultants, and outside research are often peculiar to research.

The research director and group leader can assign expenses to the proper code and determine the total expense by element for all projects and for each individual project.

Who spent the money? The answer to this question is an easy one, since the project was assigned to an individual group or area within the department when it was approved. By establishing a code to designate the various laboratory subdivisions to which projects are assigned, the research director and group leader can identify the spender.

How much was spent by type of research? Projects may call for work in application research, pilot plant research, outside research, synthesis, new methods and techniques, or any of a number of other areas. Records of these expenses are important to the research director and top management to permit control and direction and to determine the total effort or dollars expended in each category.

How much was spent by class of research? When a project is approved, it must be classified as to whether it is designed to support present investment and sales, to lead to new products and processes for the future, or to advance our fundamental knowledge. Coded expenses provide data to show management and the research director how effort or dollars are being apportioned between the present and the future.

How much was spent for individual products? In companies with several product areas, management and the research director may wish to know the expense associated with each product. Each project is classified according to the product area. Expenses of projects applicable to more than one area or those of a general nature that benefit all areas can be charged to a special category and later prorated against established areas.

THE CODING SYSTEM

By considering the questions which management wants answered we have developed a plan for classification and coding of research expenses. A typical project classified under such a coding system might be listed as follows:

Question	*Heading*	*Assigned Number*
What was the total spent?	Department	412
What was the cost of the project?	Project Number	2983
What type of expense was it?	Expense Element	218
Who spent the money?	Group or Individual	34
What was the expense by type of research?	Type of Research	12
What was the expense by class of research?	Class of Research	02
What was the expense for a product?	Product Area	07

The code would then appear as: 412 2983 218 34 12 02 07. Several code numbers—group or individual, class of research, and product area—will not change during the life of the project. Those that do must be included by the laboratory employee in his time report.

With this information, the accounting department can prepare reports that furnish short-term records for research management and top management, serve as a basis for budgets, and furnish a long-term record of cost by projects, type and class of research, and product area. These techniques can also be applied to other classifications that may be of importance in research cost control. Of course, any of them may be omitted when they do not apply.

This system is an effective method of handling direct expenses. In addition, overhead expense must also be charged to these projects. One method of accomplishing this is to prorate the overhead expense in relation to direct salaries and wages.

DEVELOPING THE BUDGET

Management controls research activities by limiting the budget with appropriated funds. Many companies use a fixed percentage of their sales to determine the research budget, and, when the sales forecast fluctuates downward, the research department is forced to reduce its planned program, usually at the expense of long-range projects. In some cases, this could prove detrimental to the future growth of the company.

A budget based on plant investment is more stable and presently is being used by some companies. This plan must remain flexible, since unusual expenditures and new development projects will require special funds.

Since technical personnel represent the largest single item in the research budget, they can be used as a cost base. A study of the year's program will reflect the proportion to be devoted to maintenance research, new-products research, and fundamental research, while detailed analysis of the individual projects will determine the manpower requirements. Finally, the cost per technical man can be determined from the various expense elements such as salaries, wages, and supplies. Preparation of other budget schedules can then follow rather easily, since the number of technical people assigned to various projects and classification areas is known. This type of computation may not always be completely accurate, since some groups may require fewer supplies or repairs and unpredictable factors can always enter into any of the projects.

Since other departments are normally charged for work of a service nature, a section must be established in the budget for credits. This can consist of items for each type of service—such as service to the production, sales, and engineering departments—or all may be included in one item.

In effect, then, a gross and a net budget are developed. It is the net budget that determines the scope of the research effort, since it is within its limits that actual research projects are accomplished.

Once expenses are classified, a budget schedule can be developed to match them. Periodic reports from the accounting department will then show actual expense versus budgeted expenses for each item on the schedule. This consolidated report provides the basic information needed for control of the research program.

With these data, management can readily determine whether the research department is following the program as budgeted, and can modify or shift activities as necessary.

CONTROL OF THE RESEARCH FUNCTION

Planning is the key to control. Planning on the company level determines the amount of money that can be allocated to research, and thereby

sets the over-all budget. Planning by research management distributes these budget dollars to fit the particular program. And at other supervisory levels, planning is the key to efficient use of this money in pursuing work on specific projects.

Budget schedules are developed to reflect this planning, and cost expense reports are developed to measure performance on an expense basis and to provide means of controlling these expenditures.

With proper budgeting and cost-reporting procedures, management has the tools to analyze, control, and schedule research activities to the best future interests of the company.

28. CONTROLLING RESEARCH COSTS WITH A BUDGET

Adolph G. Lurie*

Mr. Adolph G. Lurie lists and discusses the factors of importance when using the budgetary process to control research costs.

The budgeting and cost control principles used in effective management of the manufacture and sale of products can also be used by management in controlling the expenditures for research and development.

The establishment of a research and development budget in total is a relatively simple matter. However, the preparation of such a budget for effective cost control is a more comprehensive procedure. The methods which may be followed for both steps will be outlined here.

Budgets for research and development can be established by several different methods depending upon the viewpoint of top management. Suggested methods for determining the amount of dollars to be expended during a given period, usually a year, can be based upon any one of the following considerations, or any combination of them that management may desire to recognize:

1. The total amount of the budget may be based upon the sales for the past period or it may be a fixed percentage of the estimated sales for the ensuing period.
2. It may be desirable to budget a percentage of net profits before taxes.
3. Management may decide to base the budgeted expenditure upon the

* From *National Association of Cost Accountants Bulletin,* XXXIV, 7 (1953), 894-901. Reprinted by permission of the National Association of Accountants.

amount that had been spent previously, modified either upwards or downwards by changes in volume of sales, changes in profits, or similar considerations.

4. The research budget may be dependent upon the operating budget and the amount determined from the forecast of sales or upon budgeted profits before research and development.

5. A general review and study of economic conditions, future prospects, competition, etc. may influence the establishment of the budget.

6. The least scientific method of approaching this problem is to fix the amount by arbitrary determination.

Thus the total amount of the budget for research and development is established in one or more of these ways and the first major premise for the budgetary and cost control of a research and development department is provided. It is just a starting point for this purpose. Merely establishing a budget does not give the directors of the research department any guide for programing their efforts. Such guidance is invaluable for those who must make decisions, direct the orderly progress of the development program, and intelligently plan and control the work of the department.

The preparation of the budget is a twofold operation, consisting of setting up a budget classified by types of expenditures, to enable the technical director and supervisors to provide for facilities and staff in accordance with the amount of money available (EXHIBIT 1) and also a budget for projects contemplated during the period (EXHIBIT 2). The order of preparation of these two budgets depends upon management's approach to the problem but both budgets are for the same dollars. These budgets should be a joint project of the research department and the budget or cost accounting department, to insure compliance with techniques established for the accounting of the expenditures. The first of the two arrangements of the budget is relatively easy to prepare and can be fairly definitely fixed. The second, which breaks the total up by projects, should provide for changes throughout the period to allow the technical director and his supervisory staff flexibility in their operations.

THE EXPENSE CLASSIFICATION BUDGET

The budget of expense classifications may be fairly simple in form but, if a comprehensive budget is desired, can also be quite involved. The degree of complexity depends largely upon the size of the department, the amount of money involved and the amount of information and control desired by those responsible for managing the research department. A basic budget may consist of:

1. *Pay rolls*—salaries and wages, including related costs, such as social security taxes, compensation insurance, group insurance, pensions, etc.

2. *Supplies and materials,* such as expendable equipment and operating supplies.
3. *Other direct operating costs.*

Such a grouping, comprising only a few figures, may be adequate for a satisfactory budget and cost control of the expenditures of a small- or medium-sized department. A description of the elements entering into each of the above classifications is shown in more detail in the comprehensive budget outline below:

1. The subdivisions under payrolls, may be the following:
   a. Salaries of professionally trained personnel.
   b. Salaries and wages of nonprofessional employees, such as laboratory technicians, draftsmen, etc.
   c. Salaries of service employees, usually stenographers, and clerical workers of the department.
   d. Plant labor, consisting of hourly workers borrowed from operating departments for specific work as required.
2. Supplies and materials consist of two major items, namely:
   a. Expendable equipment purchased for specific projects or for general use in the research department, which does not become a part of the basic equipment.
   b. Supplies and materials.
3. Other direct costs can include, but need not be limited to the following:
   a. Books, periodicals, dues, subscriptions, and similar items for the department staff or library.
   b. Travel expense.
   c. Fees for outside technical, engineering, and consulting services.
   d. Taxes, depreciation, and insurance on building, permanent fixtures, furniture, and equipment.
   e. Cost of service facilities from the plant, such as light, heat, power, steam, etc.
   f. Miscellaneous.

The largest item in a research department budget is usually the salaries and wages of those employed in the department. It is relatively simple to develop the dollar amounts by totaling the salaries to be paid to the individuals engaged in research work, including payroll taxes, insurance and the cost of other benefits. An estimate can be made of the plant labor required in the operation of the research and development department, based upon a study of previous experience.

The budget for supplies, materials, and expendable equipment can also be based upon past experience, adjusting for changes in present requirements and the relative cost of these materials. Under present conditions, even though the quantity required may be the same as for the previous year, the cost would rise due to increased prices.

Other direct costs can be readily determined from the factors involved. Dues and subscriptions are relatively fixed. The books to be purchased for the library can be based upon past experience. Travel expense depends

EXHIBIT 1

RESEARCH AND DEVELOPMENT DIVISION

Expense Budget
Year ended December 31, 1953

1. *Payroll*	
a. Technical employees	$150,000
b. Non-technical employees	30,000
c. Service employees	20,000
d. Plant labor	10,000
Subtotal	210,000
2. *Supplies and materials*	
a. Expendable equipment	25,000
b. Operating supplies	15,000
Subtotal	40,000
3. *Other direct costs*	
a. Books, dues, subscriptions, etc.	5,000
b. Travel expenses	15,000
c. Technical, engineering, and consulting fees	15,000
d. Taxes, insurance, depreciation	5,000
e. Light, heat, power, etc.	5,000
f. Miscellaneous	5,000
Subtotal	50,000
TOTAL BUDGET	$300,000

upon several factors, such as the number and location of principal meetings of technical societies, the locations of the plants of the organization, the area in which the customers are located, and the general company policy with regards to travel expense. Past experience can be a good guide in determining what the expenses might be in the future.

Technical, engineering, and consulting fees can be ascertained from a review of the projects contemplated during the period. The capabilities of the research personnel and the contemplated changes therein must be considered in arriving at the amount of money that would be spent for outside assistance.

Taxes, insurance, depreciation, light, heat and power and other similar expenses are usually fixed by the distribution of the total cost to the company and the amount to be allocated to the research and development department would, therefore, be obtained from the budget of the operating divisions.

CREDITS AGAINST RESEARCH AND DEVELOPMENT EXPENDITURES

Consideration may also be given to setting a policy with respect to credits from the operation of the research and development department resulting from:

1. The sale of finished materials produced by the research and development department.
2. The sale of unusable expendable equipment or scrap resulting therefrom.
3. The transfer of expendable equipment or other materials to operating departments.
4. Charges to customers and others for technical services.
5. Any other miscellaneous credits, depending upon the accounting policy of the organization.

In a situation in which sales may be sizable in amount and also regular, it would be advisable to establish a section in the budget for credits. Thus, management can control the situation and see that all possible credits are given to the development department. However, where sales resulting from research and development work are limited in relation to the entire research program, it would be far simpler not to include such items in the budget but to allow the division to dispose of materials as they see fit, providing an incentive to sell unusable equipment and materials, thereby increasing funds for completion of projects.

EXHIBIT 2

RESEARCH AND DEVELOPMENT DIVISION

Project Budget
Year ended December 31, 1953

	Current Budget	*Prior Expenditures*	*Total Authorized*
1. *Present products*			
a. Projects in progress			
(1) Products x improvements	$ 5,000	$15,000	$ 20,000
(2) Product y usage	10,000	10,500	20,500
(3) Product z quality	10,000	7,500	17,500
Subtotal	25,000	33,000	58,000
b. New projects			
(1) Product x new process	25,000		25,000
(2) Product y quality control	30,000		30,000
(3) Product z new use	20,000		20,000
Subtotal	75,000		75,000
Total present products	100,000	33,000	133,000

2. *New product research*			
a. Projects in progress			
(1) Product xx	15,000	12,500	27,500
(2) Product yy	10,000	5,000	15,000
Subtotal	25,000	17,500	42,500
b. New projects			
(1) Product P	30,000		30,000
(2) Product Q	25,000		25,000
(3) Product R	10,000		10,000
Subtotal	65,000		65,000
Total new products	90,000	17,500	107,500
3. *Pure research*			
a. Projects in progress			
(1) Item S	5,000	3,500	8,500
(2) Item T	7,000	3,000	10,000
Subtotal	12,000	6,500	18,500
b. New projects			
(1) Item U	3,000		3,000
(2) Item V	5,000		5,000
Subtotal	8,000		8,000
Total pure research	20,000	6,500	26,500
4. *Sales department service*			
a. Projects in progress			
(1) Product x	7,000	1,000	8,000
(2) Customer z	3,000	1,500	4,500
Subtotal	10,000	2,500	12,500
b. New projects			
(1) Product y	2,000		2,000
(2) Product q	3,000		3,000
Subtotal	5,000		5,000
Total Sales Department service	15,000	2,500	17,500
5. *Service departments*			
a. Library	10,000		10,000
b. Drafting room (general)	5,000		5,000
c. Stenographic and clerical	10,000		10,000
	25,000		25,000
6. Balance for unauthorized projects	50,000		50,000
	$300,000	$59,500	$359,500

THE PROJECT BUDGET

We have discussed the establishment of a budget by classes of expenditures. However, the important phase of research budgeting for cost control is the preparation of a budget for each project to be undertaken

during the period. This likewise can be relatively simple or quite elaborate, depending upon the degree of management cost control desired. The simplest procedure would be merely to list the projects which will be undertaken, showing the amount of the budget allocated to each. Provisions should be made for additions to the list of projects during the period as new fields of research are entered. The total of the amounts authorized for the several projects must agree with the total of the amount budgeted by classes of expenditures.

A more detailed approach to budgeting research projects might be one in which projects are grouped under several headings. Major classifications could be as follows:

1. Improvement in the manufacture, quality, and usage of present products.
2. Research and development of new products.
3. Projects requested by customers or the sales department.
4. Pure or "blue sky" research, having no commercial value.
5. Service departments, research library, clerical, stenographic, drafting room, etc. This should provide only for that portion of research and development expense not directly allocable to projects.
6. Balance available for the projects to be authorized at a later date.

Under the first four of the above classifications, there could be a specific budget authorized for each project, in groups as follows:

1. Completion of projects authorized in prior periods.
2. Projects to be started in current period.

EXHIBIT 2 is a sample form which could be followed in setting up this portion of the budget. As previously stated, the total of all the items entered on it must agree with the total expense classification budget.

A logical starting point is a determination of the amount necessary to complete projects already in progress. Another portion of the budget easily determinable is the cost of operating the research service departments. These two factors, deducted from the total budget, result in the balance available for new projects. The research directors and supervisors can then determine the portion of this remainder to be allocated towards research relating to products presently being produced, new products, or for pure research. The manner in which the totals for each of these major classifications is determined, depends upon the nature of the business and the direction in which research and development effort is to be expended, based upon the policy of the organization.

Following the determination of the amount for each major classification, the next step is an apportionment to the individual projects being considered for active investigation. In this apportionment, no attempt should be made to show the manner in which funds are to be expended, since the amount of materials, labor, or supplies required for each project cannot be determined readily and must be ascertained as the project progresses.

Under the procedure outlined, management authorizes the research and development division to spend a specified sum in its over-all operation and also specifies the amount which may be spent for the projects to be undertaken. Efforts to pinpoint the budget to the extent that a figure for the several classifications of expenditure for each project is developed, might so limit the research department as to interfere with its smooth operational functioning.

The outlined procedure provides sufficient flexibility so that the directors of research may use their own judgment in shifting the efforts within their division among the various projects. In this connection, it is advisable to revise the budgets periodically by issuing supplementary budgets. Unused balances may be transferred from projects which are completed to "balance for unauthorized projects," to new projects, or to projects in progress.

As shown in EXHIBIT 2, the project budget, it is desirable to indicate the amount expended before the current period, it being assumed that such amounts plus the budget for the current period, will be the total amount authorized to date for each project. The total budget for the individual project is an extremely important guide for management, since control of the total expenditure should be maintained to decide whether a project should be abandoned or continued to its successful conclusion. It should be recognized that a long-range program must be established and provisions should be made so that the full program can be completed without capricious change of policy on the part of financial executives.

MAKING THE RESEARCH BUDGET AN EFFECTIVE TOOL

Upon the completion of the expense and project budget, approval by top management is desirable and usually required. A letter of transmittal of the budget, outlining the high spots and indicating the anticipated results of the research effort, is quite helpful for obtaining a prompt approval. In preparing the budget, a realistic and practical approach should have been used, so as to enable management readily to foresee the beneficial results of the proposed efforts. The budget should not be top-heavy on pure research or nonproductive work and, depending upon the nature of the business, should have sufficient stress upon the improvement in present products, either from the production, quality, or use viewpoint and upon the development of new products. This is desirable to obtain the proper interest, enthusiasm and approval of top management.

The budgeting procedure described here is of value only if actual expenditures are properly recorded in accordance with the budget, and comparisons made between the amounts actually expended and those authorized. Cost records are advisable, as well as monthly or quarterly

cost reports in form similar to the budget, so that those responsible for the functioning of the research department can control the expenditures and determine the amount of funds available for subsequent operations. With such budgeting and reporting, the research director can plan for the future, and financial executives can assist in the direction of the research and development division towards the ultimate goal of all concerned namely, progress for the organization, growth, and additional profits.

29. "OPERATIONS RESEARCH" FOR MANAGEMENT

Cyril C. Herrmann and John F. Magee*

The scientific method—as practiced in physics, biology, and chemistry—is the basis of a new approach to business problems. The article describes several operations research applications and discusses the factors affecting their use in business.

There is a new concept in management. It is called operations research. It has helped companies to solve such diverse business problems as directing salesmen to the right accounts at the right time, dividing the advertising budget in the most effective way, establishing equitable bonus systems, improving inventory and reordering policies, planning minimum cost production schedules, and estimating the amount of clerical help needed for a new operation.

Operations research makes possible accomplishments like these and many others because (a) it helps to single out the critical issues which require executive appraisal and analysis, and (b) it provides factual bases to support and guide executive judgment. Thus, it eases the burden of effort and time on executives but intensifies the potential of their decision-making role. In this sense operations research contributes toward better management.

What is this thing called operations research? How does it work? How does it differ from other services to management? Where can it be used? How should management get it organized and under way? What are its limitations and potentials? These are all questions that we shall try to answer in the following pages.

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ESSENTIAL FEATURES

Operations research apparently means different things to different people. To some businessmen and scientists it means only the application of statistics and common sense to business problems. Indeed, one vice president of a leading company remarked that if his division heads did not practice it every day, they would not last long. To others it is just another and perhaps more comprehensive term for existing activities like market research, quality control, or industrial engineering. Some businessmen consider it a new sales or production gimmick; some, a product of academic people interfering in the practical world. In truth, operations research is none of these things, as we shall soon see.

It should not be surprising that there has been this confusion. Operations research is not an explicit, easily identifiable concept that developed to meet the specific needs of industry. It was first applied in World War II by groups of scientists who were engaged by the government to help frame recommendations for the improvement of military activities. After the war a few soundly managed companies experimented with it and found that it worked successfully in business operations as well; and it has since gained a secure foothold in industry.

Early attempts by operations analysts to describe their activities, based on the objective of arriving at a precise and comprehensive definition of operations research, tended to be overly generalized, broad, and self-conscious, and suffered from emphasis on military applications. Some of the confusion surrounding the meaning of the term, operations research, has resulted from attempts at identification with special techniques or unnecessarily rigid distinctions between operations research and other management service activities.

Now, let us see if we can cut through some of this confusion.

The first point to grasp is that operations research *is* what its name implies, research on operations. However, it involves a *particular* view of operations and, even more important, a *particular* kind of research.

Operations are considered as an entity. The subject matter studied is not the equipment used, nor the morale of the participants nor the physical properties of the output; it is the combination of these in total, as an economic process. And operations so conceived are subject to analysis by the mental processes and the methodologies which we have come to associate with the research work of the physicist, the chemist, and the biologist—what has come to be called "the scientific method."

THE SCIENTIFIC METHOD

The basic premise underlying the scientific method is a simple and abiding faith in the rationality of nature, leading to the belief that phenomena have a cause. If phenomena do have a cause, it is the scientist's

contention that by hard work the mechanism or system underlying the observed facts can be discovered. Once the mechanism is known, nature's secrets are known and can be used to the investigator's own best advantage.

The scientist knows that his analogue to nature will never be entirely perfect. But it must be *sufficiently* accurate to suit the particular purposes at hand; and, until it is, he must repeat the processes of observation, induction, and theory construction—again and again. Note that a satisfactory solution must be in quantitative terms in order that it can be predictive—the only accepted fundamental test of being physically meaningful.

The scientific method, in its ideal form, calls for a rather special mental attitude, foremost in which is a reverence for facts. Of course all modern executives are accustomed to using figures to control their operations. But they are primarily concerned with results and only secondarily with causes; they interpret their facts in the light of company objectives. This is a much different attitude from seeking out the relationships underlying the facts.

Thus, when an executive looks at sales figures, he looks at them primarily in terms of the success of his sales campaign and its effect on profits. By contrast, when the scientist looks at these same figures, he seeks in them a clue to the fundamental behavior pattern of the customers. By the process of induction he tentatively formulates a theoretical system or mechanism; then by the inverse process of deduction he determines what phenomena should take place and checks these against the observed facts. His test is simple: Does the assumed mechanism act enough like nature—or, more specifically in this case, does it produce quantitative data such as can be used for predicting how the customers will in fact behave? For example:

> In a company manufacturing specialty products, examination of account records showed that customer behavior could be accurately described as a time-dependent Poisson process—a type of phenomenon found widely in nature, from problems in biology to nuclear physics. This concept yielded the key to establishing measures of the efficiency of the salesmen's work and of the effect of the promotion in building sales. On this basis a new method of directing promotional salesmen to appropriate accounts was constructed—and then tested by careful experiments, to see if sales increases resulted at less than proportionate increases in cost. (The results in this case were spectacular: an over-all sales rise in six figures, and a corresponding gain in net profits.)

IMPLEMENTATION

Through the years mathematical and experimental techniques have been developed to implement this attitude. The application of the scientific attitude and the associated techniques to the study of operations, whether business, governmental, or military, is what is meant by operations research.

Newton was able to explain the apparently totally unrelated phenomena of planetary motion and objects falling on the earth by the simple unifying concept of gravity. This represented a tremendous step forward in helping men to understand and control the world about them. Again, more recently, the power of the scientific method was demonstrated by the ability of the nuclear physicists to predict the tremendous energy potential lying within the atom.

Here are a few summary examples of the way this same kind of approach has been applied to down-to-earth business problems:

A company with a number of products made at three different locations was concerned about the items to be produced at each location and the points at which the items would be warehoused. Freight costs constituted a substantial part of the delivered cost of the material. Operations research showed that what appeared to be a complex and involved problem could be broken into a series of rather simple components. Adaptations of linear programing methods were used to find the warehousing schedule which would minimize freight costs. The study is now being extended to determine the best distribution of products among manufacturing plants and warehouse locations in order to minimize net delivered cost in relation to return on investment.

A manufacturer of chemical products, with a wide and varied line, sought more rational or logical bases than the customary percentage of sales for distributing his limited advertising budget among products, some of which were growing, some stable, and others declining. An operations research study showed that advertising effectiveness was related to three simple characteristics, each of which could be estimated from existing sales data with satisfactory reliability: (a) the total market potential; (b) the rate of growth of sales; (c) the customer loss rate. A mathematical formulation of these three characteristics provided a rational basis for distributing advertising and promotional effort.

In a company making a line of light machines, the executive board questioned the amount of money spent for missionary salesmen calling on customers. Studies yielded explicit mathematical statements of (a) the relation between the number of accounts called on and resulting sales volume and (b) the relation between sales costs and manufacturing and distribution costs. These were combined by the methods of differential calculus to set up simple tables for picking the level of promotion in each area which would maximize company net profits. The results showed that nearly a 50% increase in promotional activity was economically feasible and would yield substantial profits.

An industrial products manufacturer wanted to set time standards as a basis for costs and labor efficiency controls. The operations research group studied several complex operations; expressed the effect of the physical characteristics of products and equipment and the time required to produce a given amount of output in the form of mathematical equations; and then, without further extensive time study or special data collection, set up tables of production time standards according to product characteristics, equipment used, and worker efficiency, which could be applied to any or all of the production operations.

A company carrying an inventory of a large number of finished items had trouble maintaining sound and balanced stock levels. Despite careful attention and continued modification of reorder points in the light of experience, the

stock of many individual items turned out to be either too high for sales or inadequate to meet demand. The problem was solved by a physical chemist who first collected data on the variables, such as size and frequency of order, length of production and delivery time, etc.; then set up an assumed system, which he tried out against extreme sales situations, continually changing its characteristics slightly until it met the necessary conditions—all on paper (a technique well known to physical scientists); and thus was able to determine a workable system without cost of installation and risk of possible failure.

These examples should serve to give some idea of how the scientific method can be applied. But they represent only a few of the many scientific techniques available (as we shall see when we examine further cases in more detail). Some practitioners even take the rather broad point of view that operations research should include the rather indefinite and qualitative methods of the social fields. Most professional opinion, however, favors the view that operations research is more restricted in meaning, limited to the quantitative methods and experimentally verifiable results of the physical sciences.

BASIC CONCEPTS

There are four concepts of fundamental importance to the practice of operations research: (a) the model, (b) the measure of effectiveness, (c) the necessity for decision, and (d) the role of experimentation.

THE MODEL

The most frequently encountered concept in operations research is that of the model—the simplified representation of an operation, containing only those aspects which are of primary importance to the problem under study. It has been of great use in facilitating the investigation of operations. To illustrate with some familiar types of "models" from other fields:

1. In aeronautical engineering the model of an aeroplane is used to investigate the aerodynamic properties in a wind tunnel. While perfectly adequate for this purpose, it would hardly do for practical use. It has no seats; it may not even be hollow. It is, however, a satisfactory physical model for studying the flight characteristics of the ship.
2. Another, quite different kind of model, with which we are all familiar, is the accounting model. This is essentially a simplified representation on paper, in the form of accounts and ledgers, of the flow of goods and services through a business enterprise. It provides measures of the rate of flow, the values produced, and the performances achieved, and to that extent is useful (though it is hardly a realistic representation of *operations*).
3. Many models are used in physics. Three-dimensional models of complex molecules are probably most familiar to laymen, but the most powerful models in this field are sets of mathematical equations.

There are several different types of operations research models. Most of them are mathematical in form, being a set of equations relating significant variables in the operation to the outcome. An example, illustrating how a company used a model to improve time standards on the production line, is provided in EXHIBIT I.

Another type of model frequently used is the punched-card model, where components of the operation are represented by individual punched cards; masses of these are manipulated on standard punched-card equipment. For example, in a study of a sales distribution problem, each customer, of thousands served by the company, was represented by a punched card containing significant information about his location, type of business, frequency of purchase, and average rate of business. The punched cards representing the customers could then be subjected to assumed promotional treatments, with the effects of the promotions punched into the cards. The resulting business could be calculated and an evaluation made of alternative sales-promotion campaigns.

Occasionally a model is physical like the ones often used by engineers. For example, the use of a hydrokinetic model has been proposed in the study of a mass advertising problem. The fluid flowing through the model would represent business of various types going to the company or to competitors as a result of various forms of the company's own and competitive promotional efforts (represented in the model by forces acting on the fluids).

Operations research models can also be distinguished as exact or probabilistic:

1. An *exact* model is used in operations or processes where chance plays a small role, where the effect of a given action will be reasonably closely determined. Exact models can be used, for example, in long-range production scheduling problems in the face of known or committed demand. The exact model is sufficiently accurate since it can be assumed that, barring a major catastrophe, over the long run planned and actual production will be reasonably close.

2. The *probabilistic* model, on the other hand, contains explicit recognition of uncertainty. Such models are of great use in the analysis of advertising problems, where the unpredictability of consumers plays a great role. And as EXHIBIT II indicates, they make extensive use of the highly developed theory of probability, which has come to be of such great value in the physical sciences. One customarily thinks of a physicist as dealing with rather exact concepts and highly predictable experiments. Yet physicists faced a problem equivalent to the advertising problem in predicting atomic activity. Methods developed for physical problems involving mass behavior under random conditions can be applied with great facility and value to operations.

The model is a major goal of the operations research analyst. In one sense, the construction of the model, or a faithful representation of the operation, is the scientist's primary job. In doing it he develops a theory

to explain the observed characteristics of the operation. In EXHIBIT III, for example, note how the investigators linked together the salient characteristics of such diverse and complicated operations as sales, promotion, manufacturing, and distribution. The remaining task is to interpret this theory through the manipulation of the model, whether mathematical or physical.

MEASURE OF EFFECTIVENESS

Related to the concept of a model or theory of operation is the measure of effectiveness, whereby the extent to which the operation is attaining its goal can be explicitly determined. One common over-all measure of effectiveness in industrial operations is return on investment; another is net dollar profit. Measures of effectiveness down the scale might be the number of customers serviced per hour, the ratio of productive to total hours of a machine operation, etc.

A *consistent* statement of the fundamental goals of the operation is essential to the mathematical logic of the model. (It does not matter if the goals are complex.) Just as the model cannot make 2 and 2 add up to 5, so it is impossible to relate fundamentally inconsistent objectives and produce consistent and meaningful results.

EXHIBIT I. USE OF MODEL IN MATHEMATICAL FORM

The Acme Products Company wanted to set time standards for cost accounting and labor control on the operations of a battery of taping machines. These machines wind a variety of protective tapes on steel cables. The cable is pulled through the center of a rotating disk, the "taping head," which carries a roll of tape; and this tape is unwound through a set of rollers and presented to the cable at an angle. Several kinds of metallic, paper, cloth, and rubberized tapes are used, and the diameter of the cable treated varies widely.

The machines used by the company had been purchased at different times and were felt to be rather varied in operating characteristics, although the principle of operation was the same in all. Time-study methods had failed to yield adequate standards because of the complexity and variability of the operators' tasks and the uncertain effects of changes in materials. Statistical (correlation) methods applied to job records of the time and character of jobs failed to explain the variations in time required, and there appeared to be substantial differences in efficiency among machines and operators.

Discussions with operators and foremen indicated that setup and starting time and complexity were largely the same for all jobs, but the workers set the machine speeds from experience and "feel" of what the tapes used would stand without undue breakage. Investigation indicated that the tension in the tape was proportional to its speed and the tensile strength was proportional to its width.

The simplest unit of production is the amount produced by the machine in one revolution of the taping head, the unit recorded on the work sheets as the

"lay" of the tape. If the taping head turns at n revolutions per minute, the time required for a job is

$$T = t_0 + \frac{L}{nl}$$

where t_0 is setup time, l is the "lay," and L is the length of cable in the job.

From the geometrical relationship shown in Figure 1 the velocity of the tape

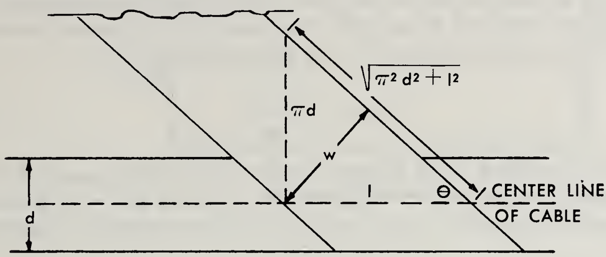


FIGURE 1

is $n\sqrt{\pi^2d^2 + l^2}$ and the maximum tension the tape will stand is $Kn\sqrt{\pi^2d^2 + l^2}$ where K depends on the strength of tape used. The maximum speed of the machine is

$$n = \frac{Q_1 w}{\sqrt{\pi^2d^2 + l^2}}$$

where Q_1 depends on the tensile strength of tape material.

The cable diameter and lay are set independently and an appropriate tape width chosen. The required width, from Figure 1, is

$$w = l \sin\theta = l \frac{\pi d}{\sqrt{\pi^2d^2 + l^2}}$$

and thus the maximum speed for the machine is

$$n = \frac{Q_1 l \pi d}{\pi^2d^2 + l^2}$$

The time required to cover a cable of diameter d and length L, with a tape of material type i at a lay l, is

$$T = t_0 + \frac{L}{Q_1 l}\left(\frac{\pi^2d^2 + l^2}{l\pi d}\right)$$

Application of this formula to routine job-production records, with appropriate allowances for the types of tape material used, showed that the operation was surprisingly uniform and that the behavior of machines and operators was surprisingly similar. Apparent differences were due to unnoticed effects of differences in jobs handled. A direct basis was available for setting uniform and reasonable time standards.

EXHIBIT II. PROBABILISTIC MODEL

The classical newsboy problem discussed in Morse and Kimball, *Methods of Operations Research* (John Wiley & Sons, Inc., 1951), illustrates the construction of a simple probabilistic model. While the example itself is trivial, it illustrates how probabilistic considerations affect results.

A newsboy buys papers at 2 cents and sells them at 5 cents; he receives a 1-cent allowance on unsold papers. He finds by experience he has 10 customers a day, appearing at random; that is, he has no regular customers and one person passing is as likely to buy as the next. Under these circumstances, the Poisson law may be expected to describe the number of customers arriving. The chance that m customers will arrive on a given day is given by

$$P(m) = \frac{e^{-10}\, 10^m}{m!}$$

Suppose the newsboy buys k papers and m customers appear. If m is equal to or less than k, m papers are sold at a total profit of $4m - k$; if m is greater than k, k papers are sold at a total profit of $3k$. The newsboy's expected profit is

$$E_k = \sum_{m=0}^{k} (4m - k)P(m) + \sum_{m=k+1}^{\infty} 3kP(m)$$

The chance he will be able to service all the customers who will pass by is

$$S_k = \sum_{m=0}^{k} P(m)$$

Figure 2 shows how the newsboy's profit depends on the number of papers he buys, k, and Figure 3 how his ability to service customers depends on the papers he takes.

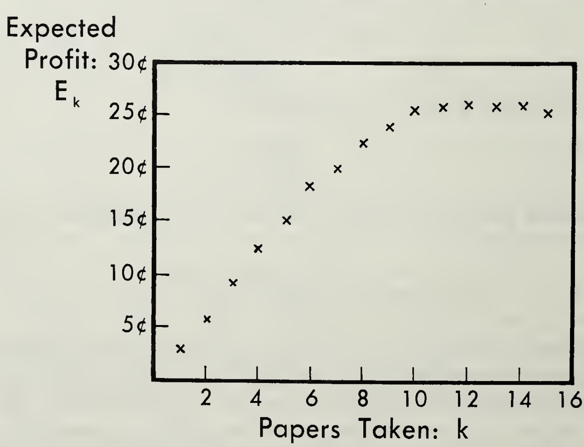


FIGURE 2

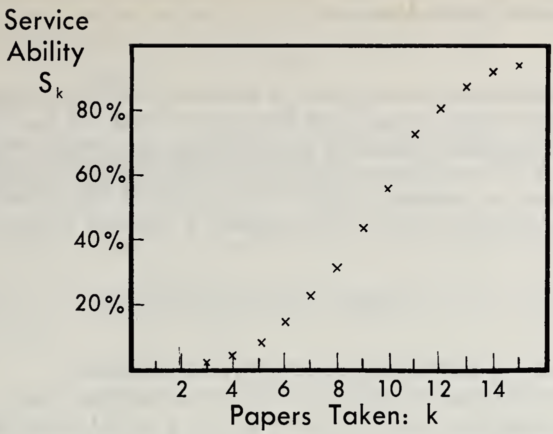


FIGURE 3

Because of chance variations in the number of customers available, if the newsboy buys 10 papers every day, he will not average the expected 3 cents per paper or 30 cents per day and will meet the available demand less than 60% of the time. In fact, he can make a little more profit by buying not 10 but 12 papers daily; if he buys 15 daily, he can make the same total profit on the average while meeting the available demand 95% of the time.

EXHIBIT III. INTEGRATING COMPONENTS OF A COMPLEX OPERATION

The Omega Machine Company sells portable industrial machinery, parts, and supplies to a large number of industrial users. Orders are received through a number of branch offices around the country, with missionary salesmen used to visit accounts to explain and promote use of the company's products. The company had tried to hold missionary sales expense to a fixed percentage of sales, with about 40% of the accounts receiving calls in any one quarter. Statistical methods based on previous business were used for selecting the accounts to be promoted.

Investigation showed the missionary sales expense to be proportional to the number of calls made rather than to the size of accounts called on, and because of the nature of the products, total volume from an account depended on the number of orders placed, since average order value was essentially the same from all accounts. Study of individual account records showed that if promoted in any quarter an individual account has a probability $P(n)$ of placing n orders in that quarter:

$$P(n) = \frac{e^{-c}c^n}{n!}$$

where c is the account's "ordering characteristic." While the ordering characteristics of individual accounts were unknown, mathematical analysis of sales

records indicated that the fraction $Q(c)$ of accounts with an ordering characteristic equal or greater than c is

$$Q(c) = e^{-c/S}$$

where S is the average for the group of accounts. While the value of S varied somewhat from region to region and from year to year, the mathematical form of $Q(c)$ is remarkably constant. This knowledge permitted comparison of results in widely different regions and times, which yielded the results that:

1. The group of accounts picked in any quarter for promotion by the company's procedure showed a distribution of ordering characteristics, c, of the form

$$Q'_p(c) = \frac{(1 - e^{-g/S})e^{-c/S}}{S}$$

where $g = a/1 - a$ and a is the size of the fraction selected.

2. If an account was not promoted in any quarter, there was a 30% chance it would be completely inactive, but if active, it would order at a rate only 70% as great as if promoted; the net effect of lack of promotion was a cut of 50% in the potential value of the account.

These two results were summarized in an equation which showed how total business, $B(a)$, depended on the amount of missionary effort expended:

$$B(a) = NV\left\{\int_0^\infty \frac{c(1 - e^{-g/S})e^{-c/S}}{S}\,dc + .5\int_0^\infty \frac{ce^{-(c+g)/S}}{S}\,dc\right\} = \frac{NSV}{2}(1 + 2a - a^2)$$

where N is the total number of accounts, V is the average order value, and Na is the number of accounts selected by the usual means for promotion. The cost of the promotional work would be expressible as pNa.

A detailed investigation of manufacturing and distribution operations resulted in the conclusion that the total manufacturing costs (including an interest charge imputed against capital employed in manufacturing and inventories) could be expressed simply, as shown in Figure 4. The break in the curve is due to the effect on costs of reaching capacity of existing plants, although operations are currently well below this level.

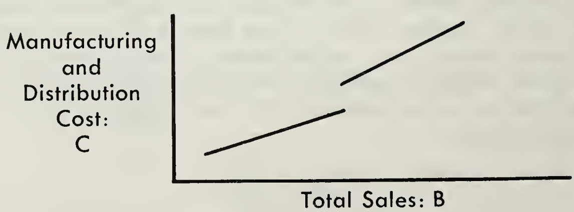


FIGURE 4

The facts learned about manufacturing and distribution costs could be combined with the information on sales and promotion to write down an equation for the profit $P(a)$ resulting from any given promotion effort

$$P(a) = m\frac{NSV}{2}(1 + 2a - a^2) - pNa - \{A - bB(a)\}$$

where m is the average gross profit and the last two terms are the manufacturing costs incurred when a volume $B(a)$ is produced. Then

$$P(a) = (m - b)\frac{NSV}{2}(1 + 2a - a^2) - pNa - A$$

By the methods of differential calculus, the profit $P(a)$ will be greatest when a is chosen so that

$$P'(a) = (m - b)NSV(1 - a) - pN = 0$$

or when

$$a = 1 - \frac{p}{(m - b)SV}$$

The arbitrary method of setting the missionary sales budget as a fixed percentage of sales was replaced by a means for relating sales effort directly to profits through the impact on sales and manufacturing. The management had a numerical basis for increasing missionary sales effort by over 50% with expectation of a handsome return.

Operations research has frequently brought to light inconsistencies in company goals. Take production scheduling, for instance. Very often its object has been stated as scheduling production to meet sales forecasts with minimum production costs, with minimum inventory investment, and without customer-service failure. Yet minimizing inventory investment typically requires the use of start-and-stop or at best uneven production plans, resulting in excessive production costs; and eliminating the risk of not being able to ship every customer order immediately requires huge inventories, in the face of fluctuating and at least partially unpredictable demand.

The solution is to combine and sublimate such otherwise inconsistent goals to a higher unified and consistent goal. To illustrate:

The diverse goals of customer service, production economy, and investment minimization can be expressed in terms of costs—the cost of inefficient production (hiring, training, overtime, etc.), the cost of investment in inventory (the rate of interest the treasurer wishes to charge to conserve his funds or perhaps the return on investment which can be earned through alternative uses of the available funds), and the cost of inability to meet a customer's demand

(estimated loss of goodwill and future business). While the latter two costs are primarily policy costs, experience has shown that they are sufficiently determinable and realistic to afford a basis for management decision.

The three component costs can then be cast in an algebraic equation expressing their interrelationships in terms of total scheduling cost; and the minimum total scheduling cost becomes the one, consistent goal.

Note that, once set up, the algebraic equation can be worked in reverse. Thus, the sales manager might be told how much the company can *afford* to pay for an inventory large enough to avoid varying risks of failure to meet consumer demand.

This kind of clarification of goals is particularly important in relating subordinate and over-all company goals—as in the case of a department run efficiently at the expense of other departments or of a promotion budget based on a fixed percentage of sales without regard to the adverse effects on manufacturing budgets.

The statement of a complete and wholly consistent goal of company operations must be recognized as an ideal. Business goals are very complex, and to catch the full flavor of the objectives of an intricate business operation in any simple, explicit statement is difficult. Many business goals remain, and probably ever will remain, at least in part intangible—e.g., efforts to improve employee morale or contribute to the public welfare. To that extent, the objective of operations research must be more modest than the construction of a complete model and the measurement of the extent to which the operation is attaining the complete set of goals established for it. But it still can serve to clarify the interdependency of those intangibles with the company goals which in fact are measurable, thus providing a guide to executive decision.

NECESSITY FOR DECISION

The third concept inherent in operations research is that of decision and decision making. An essential element in all true operations research problems is the existence of alternative courses of action, with a choice to be made among them; otherwise the study of an operation becomes academic or theoretical. This should be clear from the cases already cited.

In sum, the objective of operations research is to clarify the relation between the several courses of action, determine their outcomes, and indicate which measures up best in terms of the company goal. But note that, while this should be of assistance to the executive in making his decision intelligently, in every case the ultimate responsibility still lies with him.

ROLE OF EXPERIMENTATION

The fourth significant concept concerns the role of experimentation. Operations research is the application of experimental science to the study of operations. The theory, or model, is generally built up from observed

data or experience, although in some cases the model development may depend heavily on external or a priori information. In any event, the theory describing the operation must always be verifiable experimentally.

Two kinds of experiments are important in this connection:

1. The first kind is designed simply to get information. Thus, it often takes the form of an apparently rather impractical test. In one case the operations analysts directed advertising toward potential customers the company knew were not worth addressing, and refrained from addressing customers the company typically sought—and for a very simple reason. There was plenty of evidence indicating what happened when advertising was directed toward those normally addressed but not enough about its effects upon those *not* normally addressed. To evaluate the effectiveness of the advertising, therefore, it was necessary to find out what happened to those normally promoted when they were not promoted, and what happened to those normally not promoted when they were.
2. The other type of experiment is the critical type; it is designed to test the validity of conclusions. Again, what appear to be rather impractical forms of experimentation are sometimes used. Thus, in the most sensitive experiments of this type, the validity of the theory or model can often be tested most revealingly in terms of the results of extreme policies rather than in terms of the more normal policy likely to be put into practice.

OTHER SERVICES

Now, before going on to discuss in more detail the administrative problems and uses of operations research, it may be well to make clear how it differs from other services to management. Many of these services have been proved of great value to the business community as a result of years of successful application to difficult problems. Are there significant differences that make it possible for operations research to extend the usefulness of these services? Let us examine some of the leading services briefly for comparison:

Statistics. Operations research is frequently confused with statistics, especially as applied to the body of specific techniques based upon probability theory which has grown up in recent years. This statistical approach originally developed in the fields of agriculture and biology but has now been extended into such areas as quality control, accounting, consumer sampling, and opinion polls.

The operations research analyst does use such statistical methods when applicable, but he is not restricted to them. Moreover, there is a difference in basic point of view. Statistics is concerned primarily with the relations between numbers, while operations research is concerned with reaching an understanding of the operation—of the underlying physical system which the numbers represent. And this may make a significant difference in results as well as approach. In a recent advertising study, the operations research team found the key to characterizing the way in which the advertising affected consumers in the results of a series of "split-run" tests. Earlier, these results had

been presumed useless after statistical methods such as analysis of variance and multiple regression had failed to show meaningful conclusions.

Accounting. Operations research is also confused sometimes with accounting, particularly with the control aspects of accounting which have developed in recent years. In reality there are several differences. One springs from the fact that the fundamental and historical purpose of accounting methods has been to maintain a record of the financial operations of the company; and this is reflected in the training and attitude of many accountants. The growth of the accounting function as the interpreter of information for control purposes has been a fairly recent development, and the basic methods used and information provided are strongly influenced by the historical accounting purpose.

Accounting information is one of the principal sources of data to support an operations research study. Accounting data, however, require careful interpretation and organization before they can be used safely and efficiently. Businessmen tend to forget that accounting costs are definitions derived in the light of the fundamental accounting purpose, and sometimes they tend to confuse accounting figures with "truth." Operations research, using the same raw data, may make other definitions which serve the special needs of the particular study. One of the great stumbling blocks in the organization and implementation of an operations research study is the disentangling from accounting records of the costs appropriately defined and truly significant to the problem at hand.

It is true, however, that in the analysis and construction of measures of control, the functions of operations research and accounting do tend to overlap. Also, the men working in these functions have strong mutual interests. Accountants have served a useful purpose in bringing the importance of control measures to the attention of business management, while operations research has shown ability in building new methods for developing and implementing these concepts of control.

Marketing Research. This management service is concerned with gathering and analyzing information bearing on marketing problems. Certain marketing researchers do go so far that in some instances they are performing services akin to operations research, but for the most part they are content to measure the market, by the use of questionnaires, interviews, or otherwise, and to gather factual data which management can use as it sees fit.

By contrast, operations research, when applied to marketing problems, seeks to gain a greater understanding of the marketing operation rather than of the market itself. Thus, it may rely heavily on marketing research sources for data; in one retail advertising study, for example, a consumer-interview program was used to obtain information on the frequency with which potential customers purchased outside their own towns. But the objective, even in quantitative studies, is usually to obtain a fundamental characterization of consumers for use in the model. Furthermore, much of operations research in marketing problems is directed toward clarifying the interdependencies between marketing and other company operations. Finally, it draws on a range of techniques and analytical methods that are well beyond the scope of the usual marketing research.

Engineering. Again, the boundary between operations research and engineering is frequently unclear. Some examples may serve to draw it more definitively:

1. During the last war a great deal of effort went into the improvement of the effectiveness and efficiency of depth charges. The objective of engineering

and physics research was the construction of a depth charge having the strongest explosive power. Operations research, however, was concerned with the effective use of the depth charges then available for the purpose of sinking submarines.

2. In a recent industrial situation, the engineering problem was to construct a new railway control system which would get control information quickly and clearly to the railway engineer. By contrast, the associated operations research problem was to determine whether increased speed and clarity of control information would help the train engineer in his task of getting the train to its destination safely and quickly.

3. More subtle distinctions can be found in the study of equipment that tends to break down in operation, such as aircraft or chemical-process equipment. The engineering problem may be to find out why the equipment breaks down and how the breakdowns can be prevented. The operations research assignment is likely to be finding the best way to run the operation in view of available information on the relation between breakdown and use.

Industrial Engineering. Perhaps the most difficult distinction to make is that between operations research and modern industrial engineering. The pioneers in the field of industrial engineering did work of a character which operations research analysts would be proud to claim for their field.

In modern practice, however, industrial engineers usually apply established methodologies to their problems. Moreover, their work is generally restricted in scope to manufacturing activities and, in some cases, to distribution operations. Equally important, industrial engineering is not commonly characterized by the mental discipline and techniques of analysis that are commonly associated with the physical scientist; operations research is.

Perhaps the most significant difference marking off operations research from other management services lies in the type of people employed. Operations research people are scientists, not experts. Their value is not in their knowledge or business experience but rather in their attitude and methodology. It is indicative of the influence which the physical sciences have exerted on the people in operations research that they have a self-conscious concern with concepts and first principles and show a desire to generalize from specific examples to all-encompassing theories.

In any event, the important point is that, far from supplanting or competing with other management services, operations research has been shown by experience to be particularly successful in those areas where other services are active and well developed. Indeed, one useful contribution of operations research is frequently that of integrating other information, of using the expert opinion and factual data provided by other services in an organized, comprehensive, and systematic analysis. A soundly organized operations research group should have available the services and counsel of experts in these fields for most effective joint attack on management problems. For example:

In the continuing research program of one retail store chain operation, marketing research methods are used to provide field observations, opinions, and data on the behavior of consumers.

The accounting organization provides information on costs and capital requirements.

In the operations research models these data are combined and interpreted to yield information on cost control, staff incentives, merchandise policies, and credit management.

MANAGEMENT PROBLEMS

The task of establishing operations research in an industrial organization may be broken down into the problems of choosing the initial area for investigation, selecting personnel to conduct the work, and developing organizational plans for future growth. These problems raise many difficult and important questions to which there are no sound answers applicable to all companies, but which must be answered by each firm with particular reference to its own circumstances and needs. However, certain helpful suggestions may be drawn from experience in industrial operations research to date.

AREAS FOR INVESTIGATION

There are two kinds of starting places: (a) trouble spots where conventional techniques have failed and management feels the need for additional help and a fresh attack; (b) areas deliberately chosen to test the value of operations research because of its possible contribution to the general success of the company, i.e., without particular reference to an immediately pressing problem.

There are certain common characteristics of suitable problems on which to begin operations research:

1. There should be an opportunity for decision between alternative courses of action.

2. There should be a real possibility for quantitative study and measurement. Thus, a preliminary study to provide bases for predicting the acceptance of fabric styles had to be quickly dropped in one case because of the inability to construct within a reasonable period an adequate quantitative description of the complexities of fabric, style, pattern, and color.

3. It should be possible to collect data. In one case, analysis of accounts receivable for the previous two years yielded the key to a knotty marketing problem. But, in another case, a study of maintenance problems was found to be uneconomical because of the lack of available records showing maintenance and breakdown histories on equipment.

4. It should be possible to evaluate results readily. In other words, the problem should not be so large that it is indefinite; there should be some specific aspect which lends itself to solution. Neither the analyst nor the most enthusiastic executive can expect operations research activities to be supported on the basis of faith alone.

The final choice is best made in cooperation with the research team. Executives have found it useful to map out the general area in advance; the research group can then comment on those aspects which are most amenable to study, to clear formulation of the problem, and to likelihood of progress with reasonable effort. On this basis a specific problem can be selected which meets the requirements both of the executive (for importance and use) and of the research group (for suitability of existing data for quantitative study).

Much frustration and dissatisfaction can be avoided when the research team and the executives keep in mind each others' needs. The research team must formulate a sufficiently understandable statement of the problem and method of attack to provide the executives with confidence in giving support. The executives, in turn, must recognize that in research advance specifications for a detailed program including scope and goals are frequently difficult and usually meaningless; they must provide the group with access to the necessary data and people; and they must maintain contact with the work, guiding and redirecting it along the lines of greatest value as it develops.

EVALUATION

In perspective, what is the current status of operations research? What are its contributions, its limitations, its future?

CONTRIBUTIONS

Case histories show that operations research provides a basis for arriving at an integrated and objective analysis of operating problems. Characteristically, operations research tends to force an expansion in viewpoint and a more critical, questioning attitude. It also stimulates objective thinking, partly because it emphasizes broad purposes and partly because the mathematical nature of the model and techniques limits the influence of personal bias.

The results of operations research studies are quantitative. They provide an opportunity for sound estimates in terms of requirements, objectives, and goals, and a basis for more precise planning and decision making.

The contributions of operations research to business analysis and planning have been important and substantial. Here are two worth singling out:

1. *The application of organized thinking to data already existing within the company*—Frequently a major contribution has been the location, collection, and classification of existing data scattered through widely separated branches of the company. In one recent study, an operations research team found the same fundamental problem cropping up under various guises in a

number of different parts of the company. Each division or section had its own point of view toward the problem, and each had significant information bearing on it that was unavailable to the others. This sort of thing happens despite the most sound and progressive management; operations research tends to rectify it.

2. *The introduction of new concepts and new methods of analysis*—Some of these concepts, such as information theory, control theory, and certain aspects of statistical mechanics have been carried over from other fields; the physical sciences, and in particular modern physics, have been a very fruitful source of transplanted analytical techniques. But there are also certain original contributions, such as the newborn theories of clerical organization and consumer behavior, which suggest the possibility of developing further tools for attacking important business problems. All these techniques make it possible to explore the effects of alternate courses of action before management becomes committed to one of them.

LIMITATIONS

Operations research is hardly a cure-all for every business ill; neither is it a source of automatic decisions. It is limited to the study of tangible, measurable factors. The many important factors affecting business decisions that remain intangible or qualitative must continue to be evaluated on the basis of executive judgment and intuition. Often they make it necessary to adjust or modify the conclusions drawn from the quantitative analysis of the researchers. Professional personnel in operations research strongly emphasize this distinction between the operations research responsibility for analysis and the executive responsibility for decision. They point with approval to cases like this one:

> In a recent series of conferences called to implement the results of a long and major operations research investigation, the analysts emphasized that their conclusions were based in part on the assumption that the output of a plant in question could be increased substantially at the existing level of efficiency. The executive responsible for the operation of the plant felt that this assumption was a sound one. The official responsible for the ultimate decision, however, decided to follow a more conservative course of action than the one indicated by the study, primarily because of his estimate of the psychological effect that increases in volume would have on the plant personnel.

The fact that operations research is scientific in character rather than expert means that more time is required to achieve useful conclusions than in the case of normal engineering analyses. As an applied science, the work is torn between two objectives: as "applied" it strives for practical and useful work; as "science" it seeks increasing understanding of the basic operation, even when the usefulness of this information is not immediately clear. The executive who plans to support research work of this character must be fairly warned of the need for restraint. The natural tendency to require that the studies or analyses be "practical" can, if

enforced too rigidly, result in the loss of substantial benefits. Also, the results of studies of this type are necessarily somewhat speculative. When operations research is purchased, neither the specific program to be followed, the precise questions to be answered, nor the successful achievement of results can be guaranteed.

Recognition of this difference between operations research and more conventional engineering methods is essential to the satisfaction of both the controlling executive and the analyst.

NEW HORIZONS

In conclusion, the future of operations research appears reasonably bright at the present time. Successful applications in industry are fulfilling the hopes of its early supporters, and the skepticism of businessmen is tending to break down as successful case histories pile up and become available for publication.

The areas of potential application of operations research appear broad. The future holds possible extensions such as the development of strategic concepts through the applications of the much heralded (but as yet largely untested) theory of games and by the development of a fundamental understanding of the impact of advertising and merchandising methods.

How will operations research help in the future to clarify the role of the executive? Present indications are that it will live up to its expectations of helping executives to make decisions more intelligently, but the decisions will always remain to be made. The possibility of removing all subjective and qualitative factors must be deemed at the present time to be more a hope than a real possibility, and the construction of completely consistent and logical goals, while a reasonable objective in decision making, is probably unattainable. The balancing of the responsibilities to society, consumers, owners, and employees will therefore still be the fundamental task of executives.

VIII

THE PRODUCTION PROCESS AND THE ADMINISTRATOR

30. DEPARTMENTAL RESULTS—WE GET THEM FROM OUR COMPUTER

Donald J. Coppotelli*

This article describes the integration of substantially all of a large department's data into a data processing system kept on a large-scale electronic computer. The information thus made available and the advantages thereof are discussed.

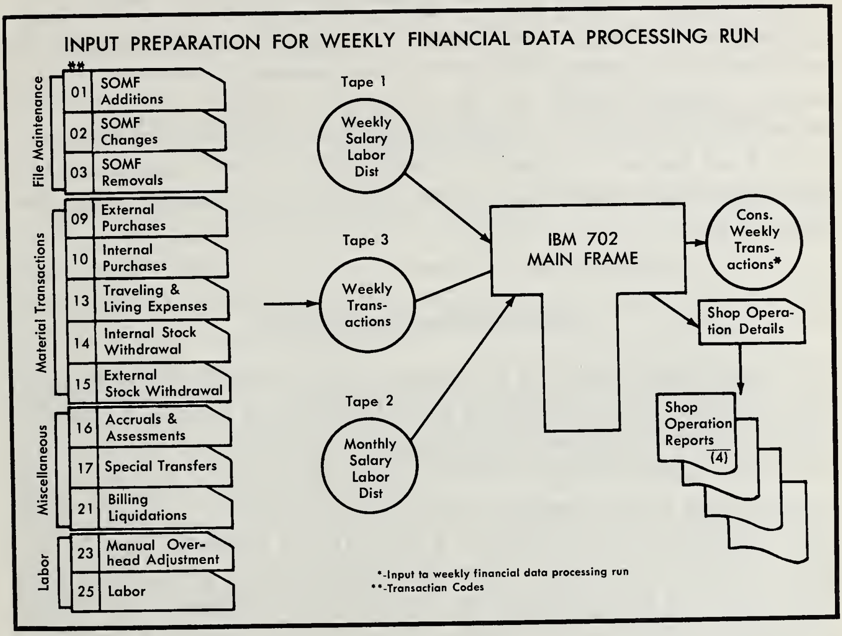
In April of 1957 a computer operator pressed the start button of the IBM 702 large-scale electronic computer located in General Electric's Computer Center in Schenectady and the machine began processing the complete financial data for one of the company's departments located in the Schenectady plant. This was the culmination of nine months of intensive research, planning and programming by a small task force of procedures specialists and computer programmers. This highly integrated system is the first of its kind in General Electric Company although, for some time prior to its inception, the computer had been used to produce payrolls and other financial data. Although a small department was used

* From *National Association of Accountants Bulletin*, XXXIX, 1 (1957), 55-61. Reprinted by permission of the National Association of Accountants.

as a prototype for this very practical application of integration through electronic data processing, it included most of the elements and financial problems of the usual operating department. Complete processing of data under the financial data processing system is accomplished by a single run on the computer each week and a separate monthly closing run.

As an example of the scope of the data being processed through the integrated system, the department using the system includes sixteen major components and more than one hundred reporting units (line foreman

EXHIBIT I



and first line supervisors) each requiring specific reporting to maintain control at the workers' level. Accounting records are maintained for more than eight thousand individual shop orders and accounts. An average week requires the processing of more than four thousand labor vouchers and seven thousand other financial transactions. Shop workers are on hourly day-work. Professional and office employees are paid on the basis of weekly or monthly salary. All time is distributed weekly. Costs are maintained on a job order cost system. Prior to setting up the integrated system, punched card equipment was used to perform most of the accounting work of the department.

The study team developed ten basic concepts around which the system was developed:

1. Shop order master file on magnetic tape
2. Automatic payments to vendors
3. Weekly shop order status reporting
4. Weekly voucher comparison reports
5. Mechanized sub-ledgers
6. Automatic monthly billing
7. Mechanized overhead reports
8. Early monthly closing
9. Integrated multi-purpose registers
10. Complete accountability at the foreman and line-supervisor level

One other feature was considered by the study team but was not incorporated in the system. This was the maintenance of inventory and inventory control records by the computer. However, this particular department's inventory was relatively small and therefore was not incorporated as a part of the system. It could easily have been included and, in other departments establishing similar type data processing system, probably will be.

THE INFORMATION "FIELDS"

The shop order master file on magnetic tape is the basis of the financial data processing system. Inasmuch as central compact storage of complete financial data is the underlying principle of the integrated computer system, a basic understanding of the shop order master file is necessary to an understanding of the complete system. This file contains over eight thousand individual records stored on a single reel of magnetic tape. It contains a record of each shop order, sub-ledger account and balance sheet control account in the department. The records are maintained on the tape in a sequence which permits weekly and monthly reports to be extracted as a finished product, with no sorting required. This is an important consideration in any tape-operated computer, since sorting is one of the least economical operations to perform on large machines of this type.

Each individual unit record in the system contains a number of fields. Each record contains the same fields and these fields are consistent in length and content, even though some of them may not be used for all types of records included in the system. These fields fall into two general type categories: indicative data and statistical data. Information stored in the indicative data fields includes such items as requisition number, shop order number, appropriation or cost estimate number, shop order title or description, and budget data. Also included in the indicative fields are a

number of codes which the computer will interrogate when processing the record to determine which overhead rate should be applied to direct labor from a table of overhead rates stored in its memory. Statistical fields include current-month accumulations of charges by classification of the charge. For example, material, various classifications of labor, overhead and billing liquidations are each accumulated separately.

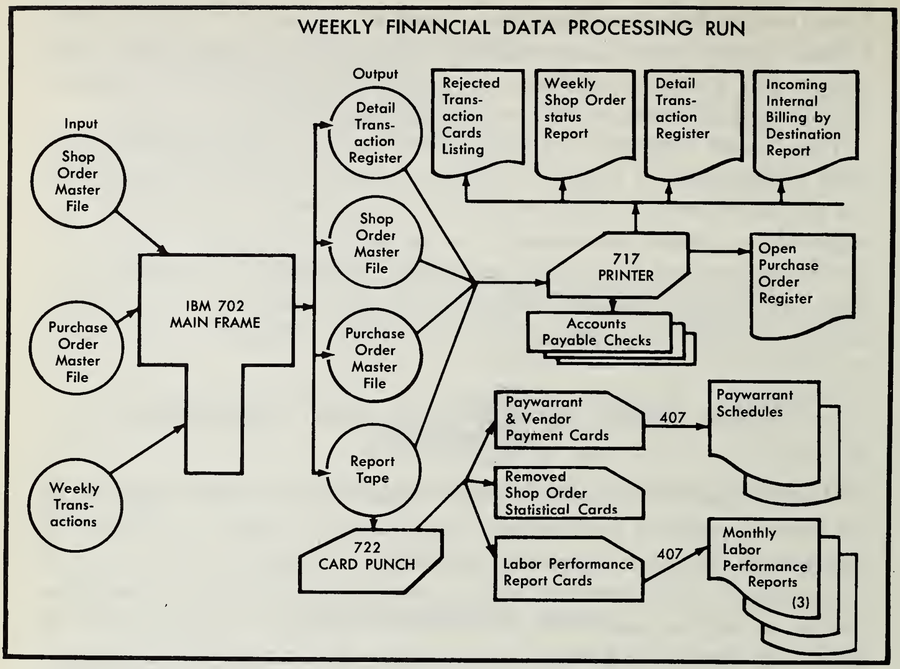
Year-to-date amounts and total-to-date are also accumulated by the same classification of charges. Unbilled balances by billing classification are also maintained for each shop order and account. As a result, all data required for general accounting, cost accounting and some elements of purchasing and orders-received accounting are included in the master file tapes. All registers, reports, billing and control totals are extracted from data summarized in the master tape on a weekly, monthly or annual basis.

JOURNAL ENTRIES SUPERSEDED BY MORE COMPREHENSIVE INFORMATION

Monthly journal entries have been replaced by transaction records in the form of punched cards which are prepared currently for all financial transactions. This has completely eliminated the journal entry system of accounting in this department, since it is no longer necessary to journalize charges in order to post to the individual records. The computer posts all details affecting an individual record at the same time, instead of accumulating all charges of a particular type in journal entries for posting to the records affected. Transaction code numbers replace the former journal entry numbers but accomplish considerably more than journal entries did under manual or mechanical systems.

EXHIBIT I shows the manner in which transactions for a given week are converted to tape for processing by the computer. It will be noticed that file maintenance type changes bear the lowest transaction numbers. Since weekly transactions are put on tape in transaction number order, this means that any file maintenance changes, such as the opening or closing of a shop order, will enter the computer before any changes occur in statistical data. For example, a shop order may be opened in a given week and charges booked to it. In addition, the transaction code indicates to the computer the exact routine from a library of routines stored in the computer's memory, which should be selected for the processing of a transaction. The transaction code tells the computer what changes need be made in the shop order master file or updates the purchase order master file or specifies the reports into which the detail card must be incorporated or establishes any special accumulations which are to be accomplished for control purposes.

EXHIBIT 2



HOW EXCEPTIONS ARE AUTOMATICALLY DISCLOSED

At the end of each week, the transaction cards are converted to a weekly transaction tape which, along with the weekly labor distribution obtained as a by-product of a prior payroll run, is used to update the thousand records contained in the shop order master file and, at the same time, produce current weekly cost and control reports. This is illustrated by EXHIBIT 2. The exception principle is followed in determining which shop orders and accounts are to be reported in any week. If a manager, supervisor or foreman does not desire a report on a specific shop order, he so indicates and this shop order account is not reported to him until he asks that it be included in his report.

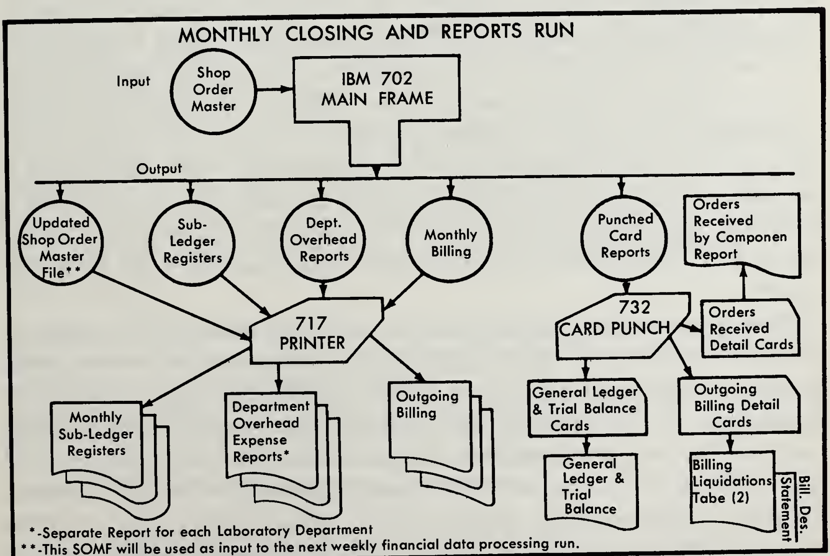
In the purchasing department, as each order is placed a by-product punched card is automatically produced. Information in this card includes the shop order number, purchase order number, and dollar value of the order. These cards are converted to a purchase order master file on magnetic tape in purchase order number sequence. When the bill is received for payment, the purchase order number and the gross amount of the bill

is converted to magnetic tape and fed into the computer along with the purchase order master file. The computer prepares checks and pay warrants covering all purchase orders for which material has been received and invoices are on hand. As the computer processes the payments to vendors, it automatically calculates the net amount of the bill and the amount of the discount. Payment will not be made unless a purchase order is available in the purchase order master file. This establishes a check against duplicate payments. In addition, if the net amount of the invoice exceeds the amount of the order, an automatic message is typed out on the typewriter on the computer console to indicate this fact.

As output from the weekly computer run, a shop order status report is prepared by the computer indicating the charges incurred during the week by classification of the charge, total-to-date expenditures and, on any account with a budget or authorized amount, the unexpended balance is printed. A weekly report is prepared for each of the more than one hundred units on the foreman and line supervision level.

Each week the computer automatically provides a voucher comparison report for both weekly and monthly paid employees as direct output from the payroll run. These reports show any excess or shortage of vouchers for each employee, both weekly and monthly, based on clock card hours or an assumed forty hours if no clock card has been submitted for the

EXHIBIT 3



week. Vouchers are not required for any employee whose time is normally charged to a standard overhead order, since the computer automatically distributes this time to the standard expense account in the employee master file.

ADVANTAGES REALIZED

One of the major advantages of the integrated system has been the early closing of the department's books. On the first Tuesday following the close of a fiscal month, the books are completely closed by a special run on the computer. This is illustrated by EXHIBIT 3. This run prepares a trial balance, a general ledger, overhead reports and an orders received report by each component of the department. All charges, including labor incurred in the last week of the month, are on an actual basis and are not accrued. Therefore, the trial balances and sub-ledgers include all of the charges distributed to several thousand shop orders. Under this system, if desired, the books can be completely closed weekly. During the conversion months of April, a weekly trial balance was actually prepared by the computer to localize any possible errors made as a result of unfamiliarity with the new system.

A monthly sub-ledger register is produced from magnetic tape, which includes all of the sub-ledgers supporting general ledger accounts. These include plant equipment, engineering orders, raw and in process inventory, overhead, plus several that are special for the department. This register eliminates the need for any manual posting formerly required. During the monthly closing run, all charges incurred against orders which may be billed during the current month are automatically billed out. Invoices are automatically prepared by the computer, including appropriate classification of charges for statistical purposes. Most of the billing of this department is done internally to other departments within the company and the computer, in addition to providing the bills, also provides billing schedules by company destination. The integrated system results in the issuance of billing two to three weeks sooner than had been done previously.

During the closing run, an overhead report is automatically prepared for each component in the department. These reports show expenditures against each overhead account on a current month and year-to-date basis. In addition to expenditures, the overhead report also contains budget analysis. The computer calculates the variable budget based upon adjusted applied labor for the month. Performance against the calculated budget is shown as a percentage. Audit symbols appear opposite the overhead account when expenditures exceed the calculated variable budget amount.

The financial data processing system has fulfilled all of the basic objectives set for it and is running successfully on the computer. It has permitted much earlier closing of the department's books, more current billing of the department's books, more current billing of the department's expenses, much earlier reporting to management and, thus, appreciably better management control through financial operation. It has resulted in an appreciable saving in clerical and machine accounting costs.

31. PLANNING THE FUTURE OF A SUCCESSFUL PRODUCT

J. Curran Freeman*

This article tells the story of the planning of expansion related to a specific company. It covers the planning of sales revenue, costs, profits, and return on investment and involves facilities and working capital planning.

There is sufficient evidence to convince even the most conservative of us that we stand on the threshold of a "golden age" in the economic and industrial life of America. We shall participate in the fruits of this great national growth directly in proportion to the thoroughness with which our planning is done. We need to undertake intelligent planning, based on supported facts extrapolated on the basis of careful projections and flexibly designed for quick modification as circumstances become more proximately known and evaluated.

This paper will not treat financial planning from the viewpoint of current interest in the subject of raising new capital to meet the needs of the greatest capital expansion in history. Provision of capital is, or may be, periodic. Hence discussion of its effective use, after it has been provided should, in my opinion, be of greater interest. This article affords us the opportunity to

1. Review a product (not an end-product) projection study just completed for one of our companies, commencing with the market analysis and culminating in a profit and loss projection.
2. Explain briefly our approach, on a project basis, to manufacturing and engineering problems associated directly or indirectly with the expansion.
3. Accord proper recognition to organization structure.
4. Highlight our control accounting techniques.

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* From *National Association of Cost Accountants Bulletin*, XXXVIII, 9 (1957), 1099-1105. Reprinted by permission of the National Association of Accountants.

The study described was essentially the work of a team. The staff director of marketing was responsible for directing the work and for final consolidation and drafting of the study. He was aided by line management, executive as well as sales, finance, manufacturing and engineering.

PROJECTING PRODUCT SALES VOLUME OVER A 3-YEAR PERIOD

The history of the product has been one basically of the inability of manufacturing facilities to keep pace with sales potential. Consequently,

EXHIBIT I

PRODUCT XYZ MARKET STUDY—EQUIPMENT INDUSTRY SALES

	Number Units	Negative Application		Possible Application		Possible Application	
Basic Market Classification	Produced in 19	Existing or New Products OEM*	INSTAL.	Existing Products OEM*	INSTAL.	New Products OEM*	INSTAL.
A		X	X			X	X
B				X	X		
C				X	X		
D	3,162,000			X	X		
E	20,000			X			X
F						X	X
G		X	X				
H	128,000			X	X		
I	9,000	X			X		
J				X	X		
K	190,000			X	X		
L	300,000	X			X		
M	23,285		X	X			
N	2,000,000		X	X			
O		X	X				
P	753,000			X	X	X	X
Q		X	X				
R		X	X				

* Original Equipment Market

it was necessary to do a market research study to find that potential. The product has an application in many markets. Hence each market in which the product has potential application was analysed in terms of units produced in 1955. These end products were then identified as to whether they might (possible applications) or would not (negative applications) provide a market for the product under review. (EXHIBIT I) The number of end products extended by the units of our product developed its potential in terms of units and dollars for the period under projection, 1957

EXHIBIT 2

COMPARISON OF TOTAL POTENTIAL MARKET AND DRESSER SALES FORECAST–EXISTING PRODUCTS

	1957*			1960*		
BASIC MARKET	Total Potential	Dresser Sales	% of Total Potential	Total Potential	Dresser Sales	% of Total Potential
A						
1	$ 796,000	$251,763	32.2%	$ 862,000	$ 427,262	50.5%
2	613,650	122,730	20.0	613,650	490,920	80.0
3	344,617	28,416	8.2	113,693	113,693	100.0
4	3,299,000	790,299	24.0	3,299,000	1,649,447	50.0

* Columns for 1958 and 1959 omitted

through 1960, as shown in EXHIBIT 2 which also carries figures for Dresser historical sales and percentage participation in the potential market. Projections were extended to possibilities of further market penetration based on price, quality and sales coverage. Through field study and customer contact, potential was verified by a study of competition, whether direct, competitive or comparable method. It can be appreciated that findings of the field study have multiple value in research and product engineering as well as manufacturing techniques and costs. To finalize the program in terms of production, it was also necessary to make a detailed study of distribution methods and techniques, not previously required in a market the potential of which so outstripped production capacity. Anticipating the results of this study in terms of forecast sales, for purposes of perspective let us say at this point that the study projects a multi-million dollar increase in sales of 300 per cent in 1960 over 1955.

FOLLOWING THROUGH TO MANUFACTURING IMPLICATIONS

Thus far we have reviewed the market potential and product forecast approach, the latter in terms of unit and dollars. Looking to production problems, the study proceeded from this point to project units and dollars in terms of styles and sizes, total potential as well as estimated Dresser participation. This detail is neither academic nor sophisticated, if the practical problems of manufacturing conversion (men, methods and machines) are kept in mind. It provided the starting point for manufacturing projection. The analysis of the manufacturing aspect of this expansion covered:

1. Equipment requirements and production capacity 1955-1960 (Equipment investment).

2. Equipment (selection and automation).
3. Manpower requirements.
4. Plant layout and plant location.
5. Manufacturing expense.
6. Cost reduction.
   a. Material cost.
   b. Labor cost.
7. Detailed manufacturing problems to be resolved.

Following the bill of materials "explosion" techniques, units of the product were reduced to parts requirements in terms of present equipment capacity and projected requirements for machine capacity during each of the years under study through 1960. As shown in EXHIBITS 3 and 4, capacity requirements were developed by parts total, machine, and capital expenditure in amount and cash date. Summarized in terms of individual machines and dollars, a proposed equipment investment of over $2,000,000 became evident. The equipment selected for immediate procurement is the net result of a complete evaluation of a two-year study and continuing conference with machinery builders, including automation studies. Based upon the production requirements as indicated through 1960, and the inventory of equipment required to effect this production, a man-power study was completed in the detail of machines, shifts and hands required. Understandably, expanding a business 300% in five years

EXHIBIT 3

PRODUCT XYZ, PLANT CAPACITY & EQUIPMENT REQUIREMENTS

(*Columns for 1957 and 1959 omitted*)

Order Date		1956	1958	1960
	Part A (Prod. Required)		11,800,000	17,400,000
	1956 Present Equip. Capac.	3,960,000	3,480,000	3,000,000
* 1956	*(1) New Equip. Type		1,600,000	1,600,000
1956	(1) " " "		1,600,000	1,600,000
1957	(2) " " "		3,200,000	3,200,000
1958	(3) " " "		9,880,000	4,800,000
1959	(2) " " "			3,200,000
				17,400,000
	Part B (Prod. Required)		11,800,000	17,400,000
	Present Equip. Capac.	8,800,000	8,800,000	8,800,000
	(1) New Equipment		8,800,000	8,800,000
			17,600,000	17,600,000
			1,670,000	2,504,000
	Assembled Product (prod.)	* on order		
	Present Equip. (Capac. O.)			

also required a plant layout study. This study included plant location and activity relocation covering the usual items of freight rates, labor availability and labor rates, detail layout of manufacturing and service facilities, and total expenditure required. Completing the preparation of raw data, a detailed yearly manufacturing expense projection was prepared through 1960.

EXHIBIT 4

PLANT CASH REQUIREMENTS FOR EQUIPMENT

Product XYZ

TOTAL	1960	1959	1958	1957	1956	CASH DATE
					80,000	1956
				80,000		1957
			160,000			1958
		240,000				1959
	160,000					1960
720,000						
			13,000			1958
13,000						
				73,000		1957
			73,000			1958
		73,000				1959
	146,000					1960
365,000						
				60,000		1957
			60,000			1958
		60,000				1959
180,000						
				54,000		1957
			54,000			
108,000						

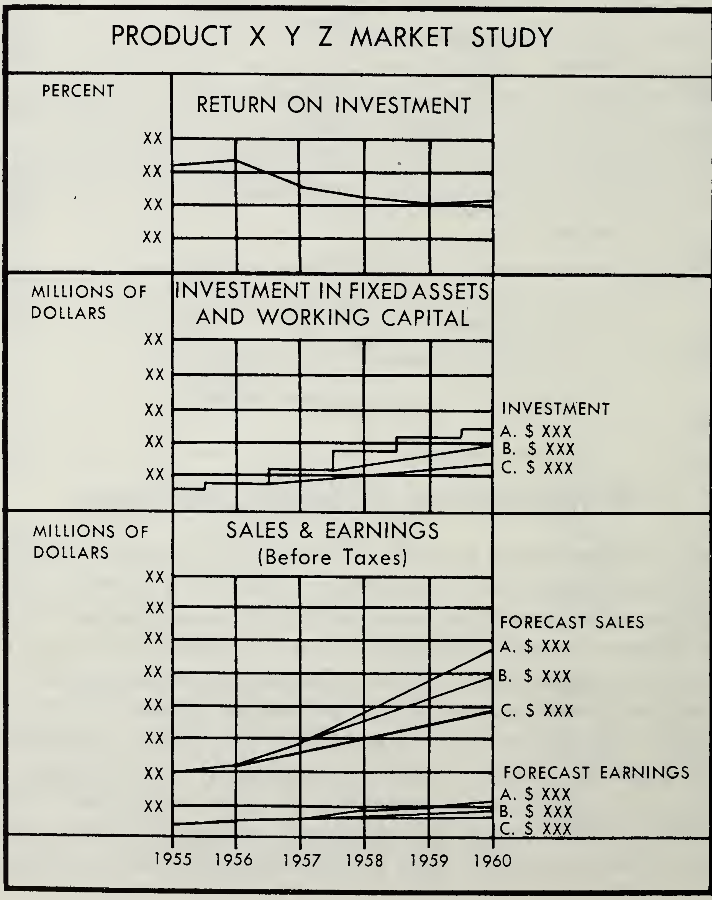
THE PROJECTION IN STATEMENTS AND CHARTS

Having the above data in hand we were able to complete a projected profit and loss statement in the customary manner. The treatment of wage differentials (on a physical relocated plant basis) and manufacturing cost savings deserves a word of comment. Labor rate differentials, particularly on a union- non-union basis, were not allowed as a cost saving claim. Time can conceivably wipe out the differential and we believe that long-range decisions to invest should be supported by long-range considerations. Though there may be good and sound arguments for estimating manufacturing cost savings, we accepted the program strictly on a straight dollar profit increase, producing the same percentage to sales as presently generated. These statements apply to the long-range. For the fiscal period

immediately ahead cost savings claimed are critically reviewed and evaluated cost- and profit-wise.

To complete the financial projection, estimated balance sheets through 1960 were prepared to develop working capital requirements and the base for the return on investment calculation. It is interesting to note from EXHIBIT 5 on which relevant data is graphically presented that return on investment declines rather sharply to 1959 and begins the upturn at that time. Long-range planning has many advantages. Projected far enough, the return on investment sometimes becomes a deciding factor to invest where short-range planning or rule-of-thumb fast payouts might cause an overly conservative management to forego a profitable opportunity.

EXHIBIT 5

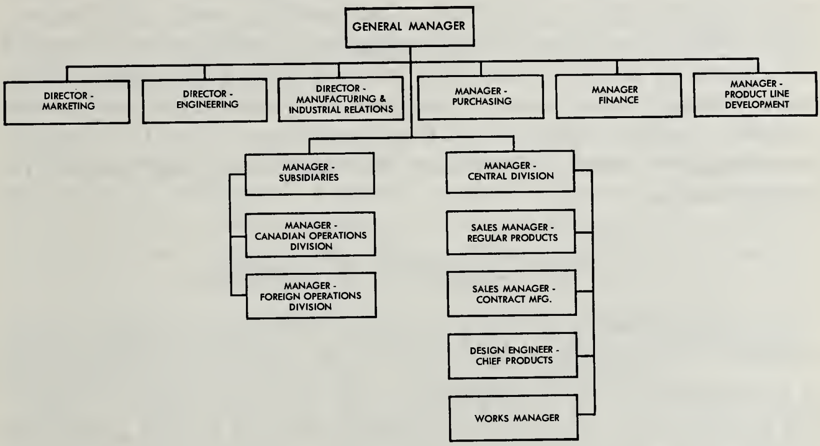


ORGANIZING FOR EXPANSION OF PRODUCT'S SALE AND MANUFACTURE

Facilities, whether land, building, or equipment, are at best inanimate tools which require management activation to produce effectively and at a profit. It is a truism to say that what is every one's responsibility is, in the last analysis, no one's responsibility. We believe in clear cut delegation of authorities and responsibilities. In the instance of this expansion, substantial as it will be, the exigencies of the business require progressive decentralization of profit responsibility, eventuating in a general managership

EXHIBIT 6

PRODUCT XYZ MARKET STUDY
ORGANIZATION PLAN



as indicated in the Organization Plan (EXHIBIT 6). In its initial stages we contemplate a product manager with complete profit planning responsibilities on a profit center basis, encompassing:

Planning	Putting Plans Into Effect
New designs for existing markets.	In all areas of
New designs for new markets.	Marketing.
New markets for existing designs.	Product research.
	Manufacturing—Tools, inventories, etc.
	Purchasing—Sources of supply.
	Cost reduction.

Review and Control

Responsibility for results (Profits)

KEEPING CONTROL OVER OPERATIONS

We have now reviewed product planning, set the plan of operation, and arrived at the point at which there is necessity for a system of review of actual results against plan as a basis for remedial action, where necessary, to control according to plan. In my experience, I have found the relationship of operating profit to gross assets to be the best measure of operating efficiency. Operating profit is the result of sales revenue less manufacturing costs and operating expenses (sales, engineering, administrative and general expenses). To be sure, there are other bases to which to relate this figure, such as net invested capital or net assets. However, gross assets as a ratio denominator measures a business on the basis of continuance instead of wasting of assets. We consider the use of fixed and variable cost and expense elements as well as the direct costing of product (adding a complement of fixed expense for inventory valuation, however), as being the most effective means of developing "responsibility costs" whether at a profit center or cost center level of management. Finally, where control of cost cannot be readily measured in terms of dollars and cents, such as broad investigative and research programs in manufacturing, engineering and sales, a project control is used. In project control we set the objective, the calculated methods of resolution, the time-phasing, and progress reporting routine.

A "NEW DIMENSION" IN INDUSTRY

Long-range planning as a "new dimension" in industry (Ralph J. Cordiner before the Economic Club of New York, March 1956), means depth of penetration in terms of investigation and perception. Depth of perception can come only from intensive planning born of critical, painstaking and minute analysis. This is the route we have taken in Dresser and have importantly changed the character of the company's operations in recent years. As recently as 1949, approximately 90 per cent of its sales volume consisted of heavy capital equipment having a long service life. As a result, sales and earning of the company, as then constituted, tended to exhibit the fairly substantial fluctuations typical of the capital goods industry. Subsequent acquisitions, as well as internal growth of the Dresser Companies, have been directed primarily toward increasing the portion of the total sales represented by expendable products and technical services. This planning has paid off handsomely. In the current year expendables will account for 60 per cent of our sales. While accomplishing this basic change, we have advanced detail profit planning from one year planning (fiscal year) to five years and now to ten.

That a long-range plan, even a five-year plan, may be subject to change causes no concern. Operating in a dynamic economy, we expect that to happen and, consequently, have, as management, designed all our plans, whether for material, men, money, or methods to allow us to quickly adjust to new found circumstances.

32. "CLOCKS" FOR MANAGEMENT CONTROL

Allen W. Rucker*

The author develops the concepts of break-even point control into a helpful system which can help the executive to control his over-all business costs and maximize his earnings.

The top executive in modern industry wants to know both profit-wise and cost-wise "where he is as against where he ought to be" at any given time. He wants to make planning and policy decisions knowing what the results must be in order to stay within certain profit and cost standards. He wants to be able to "manage by exception." He wants to know what his associates are accomplishing—and to let them know that he knows—in concrete dollar terms; for then praise and blame can be phrased in objective quantitative terms so as to spur constructive achievement.

How can the executive do these things? One of the most helpful means is breakeven point control. Now, this is not a new concept. Early this century C. E. Knoeppel, often called the "father" of breakeven point control, developed the fundamental distinction between *fixed* (better, *rigid*) expenses and *variable* costs contingent on volume.[1] But thinking about the concepts has not been static in the intervening years. There have been many discussions and publications on the subject. In recent years, in particular, a number of progressive companies have been working with breakeven point control, adding refinements to it and developing its practical effectiveness. As a result, the concept has been carried well beyond the "textbook" version which businessmen can find in libraries.

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* From *Harvard Business Review*, XXXIII, 5 (1955), 68-80. Reprinted by permission of the *Harvard Business Review*.

[1] C. E. Knoeppel, a series of articles appearing in *The Engineering Magazine*, Vol. XXXVI, October 1908-March 1909; published in book form under the title *Graphic Production Control* (New York, 1918).

In the pages to follow I shall discuss some applications of the breakeven principles which are destined, I believe, for wider acceptance among progressive companies in the years ahead. These applications center about business "clocks" which can be constructed to help an executive make sound decisions on such problems as whether:

The company will be able to pay an extra dividend if the present rate of operations continues.
The company is expanding faster than the growth of volume justifies.
The maximum permissible limits on variable selling costs in opening a new territory or in selling a new product have been reached.
A proposed advertising appropriation is sound.
A change of emphasis in selling effort among different areas is needed.
A union wage demand is justified.

The construction of these "clocks" is explained in the Appendix (where the various exhibits referred to in the text appear). For the top executive it should suffice here to point out that the "clocks" can be built for his use, that the making of them need not absorb his time and energies. For him, the paramount considerations are those of utilizing the "clocks" to control his over-all business costs and to maximize his earnings.

BREAKEVEN CHARTS

Modern industry, with its heavy plant investment, depreciation schedules, taxes, and so on, has probably made the present generation of managers as "timetable" conscious as almost any other group in the country. Company executives are continually concerned with questions pertaining to whether operations are proceeding according to schedule or not.

PERSPECTIVE VIEW

For example, here is one question commonly asked: "How much volume does our firm need in order to pay an extra dividend, how much just to cover the regular dividend, how much to break even?"

The volume spread between the breakeven point and the extra-dividend point may be as much as 150%. Or, as one management recently found, an insignificant 6% increase in volume over that forecasted in the company's executive-committee budget would mean a jump of 49% in pretax profit. That revelation sparked an immediate revision of sales quotas and the launching of two new products.

If a senior executive wants to spur his organization to new accomplishments, let him picture the possibilities in figures that disclose the end results. Not only production managers and sales managers but also directors need to have a perspective view of a firm's prospects. In one instance, the

previous reluctance of the directors to approve an expansion program evaporated in five minutes when the board was shown that the resulting 20% gain in output would raise earnings on net worth from 8.6% to 12.2% and lift pretax profits almost 90% above the prevailing level.

EXHIBIT I illustrates such a perspective view. This table, prepared for a moderate-size firm, discloses an exciting fact previously hidden even from top management: every dollar of volume *above* the breakeven point generates a pretax profit of 33.88 cents. If this carrot is not enough to spur action among executives, then the club which the table also provides can be wielded—every dollar of volume *below* the breakeven point will throw 33.88 cents in red ink on the operating statement.

(Note that in this and all other exhibits, volume is expressed in terms of production value rather than sales, for reasons explained in the Appendix.)

Other questions that are asked concern expansion. In management circles there is an uneasy awareness that breakeven points have been rising under the impetus of monetary inflation as well as with the expansion of facilities. I find that a growing number of senior executives are asking: "Are we going ahead with plant expansion faster than our realizable increase in volume? Are we increasing all forms of rigid expense—depreciation, maintenance, research, and staff personnel expense—at a rate greater than the growth rate of our business justifies?"

These questions, too, can be answered on a factual basis, using a graphic approach such as EXHIBIT II. This chart, based on the ratio of actual volume to breakeven volume over a ten-year period, shows the extent to which the volume realized in any year exceeds that required to break even (taken as 100%). The five-year or ten-year trend of this ratio—the "safety factor index"—is as revealing to management as a temperature chart is to a physician.

With this type of visual control, a manufacturer of metal products maintains an up-to-date comparison of (a) his actual volume and (b) the volume required simply to break even. Whenever the chart (the figures will do just as well) discloses a tendency for the safety factor to decline, this manufacturer knows that expansion of his organization and plant is at a rate greater than his realized business growth, to the detriment of profit. The reverse is also true; a persistent upward trend of the safety factor index may signal the need for expansion.

BUSINESS "CLOCKS"

Both EXHIBIT I and EXHIBIT II represent two forms of a business "clock" showing whether a firm is on time, behind time, or ahead of time. EXHIBIT I clocks business progress during the current fiscal year, showing what expense and pretax profit ought to be under any level of business activity;

EXHIBIT II clocks the changing spread between actual and breakeven volume. It should be emphasized that EXHIBIT I is not a forecast of business conditions, nor of business costs and business profits. On the contrary, this table is intended to show what total expenses *should be*, and what pretax profit *should be*, not only at the forecasted volume but at any other volume level above or below the forecast. For example:

> On Line II under Column B appears the company's forecasted or budgeted volume for the fiscal year. Directly opposite on the same line, under Column C, appears the standard total expense allowed at this volume (the actual computation is explained in the Appendix), and in Column D the standard pretax profit that would result. Note that the table also discloses the allowable expense and standard pretax profit for any volume level above or below that forecasted.
>
> In brief, failure to make the expected volume does not leave the executive without a profit goal on the lower volume actually realized. So also success in surpassing the expected volume does not lull management into complacency because profits are larger than budgeted; the table discloses whether or not profits are as much greater as they should be for the greater volume actually realized.

This type of control table not only shows the senior executives, almost at a glance, how much expense deviation from budget is permitted for any fluctuation in volume above or below budget, but makes it possible for executives to distinguish quickly between (a) expenses caused by changes in volume and (b) expenses caused by changes in the effectiveness of internal control of operations. To spell this out:

> Changes in volume (except when due to newly added facilities) do not automatically cause a change in rigid expense, but they do cause, almost automatically, a change in the total amount of budgeted variable contingent costs. In EXHIBIT I, standard changes in these costs are allowed at the rate of 66.12% of changes in volume, up or down (the computation of this figure is explained in the Appendix). For example, the difference in total costs between lines 5 and 6 ($243,414) is 66.12% of the difference in volume shown opposite these two lines—i.e., 66.12% × $368,147.
>
> On rising or falling volume, any change greater than this 66.12% is an indication that internal management control over costs is less effective than that required to meet planned results; any change less than 66.12% shows that control is more effective than planned.

By means of such "clocks" senior executives can more easily call a halt to alibis and to rationalizations of a poor showing, or, for that matter, of an improved showing that still fails to come up to standard.

USES OF "CLOCKS"

Management will find it convenient to divide the uses of the control "clocks" into two categories: (1) business policy and planning decisions; and (2) operations control, both of costs and of income.

A few examples from experience will illustrate both types of use and will suggest a number of others.

POLICY AND PLANNING

Expansion of plant by either new building or acquisition of other firms increases both production value and (because of increased depreciation and executive supervisory personnel) rigid expense. Hence, the breakeven point tends to rise. This is normal. The factor to watch is the ratio between rising production value and a rising breakeven point. If this ratio shows an upward trend, the expansion policy is justified: if the trend declines, the management may be overdoing matters. In the case of the company concerned in EXHIBIT II, for instance, it was evident that plant growth was tending to outstrip the gain in production value; the safety factor signaled "caution" with respect to further additions to capacity.

Limiting Sales Expense. The experience of a manufacturer of a diversified line of printed products illustrates another use of these "clocks":

> In a situation marked by rising sales volume but also by diminishing profits, the locus of the trouble was traced to sales expense above standard. A breakdown of production value by sales areas resulted in a statement for each area similar to that in EXHIBIT IV.
>
> In two geographical areas, it was found that variable contingent sales expense not only exceeded the over-all company average but actually exceeded the entire operating margin above variable manufacturing and administration expense. (In the case of the company in EXHIBIT IV, a comparable situation would have existed if item 4-b-2 had been 48.54%.) In those two areas the firm was, in effect, giving away the merchandise plus 9%; that is, total variable costs were 109% of production value.
>
> The sales manager was given six months in which he could either correct the situation or abandon all sales effort in those areas.

This is not to say that variable sales costs in *some* territories may not properly be higher than the company average for that type of expense. But there is a limit, and it obviously must be somewhere under 100% of the production value generated by the territorial sales. With variable contingent costs once determined, the precise maximum limit on variable selling costs in introducing a new product or opening a new sales area without a *cash* loss can be found from a statement like EXHIBIT IV. To illustrate:

Production value		100%
Less: variable manufacturing costs (includes labor's share of production, or the cost of hourly rated factory labor)	52%	
Less: variable administration expense	5	57%
Maximum permissible for variable selling costs without suffering an out-of-pocket cash loss		43%

Naturally, no one deliberately goes up to this limit or above it unless he has to, and then only temporarily. But without knowledge of this limit, who is to know by how much the limit is exceeded and for how long? A "clock" of the type shown in EXHIBIT IV for each prospective *new* sales territory or *new* product can be invaluable to top management. A like treatment may well apply in some or all *old* territories.

Exploiting New Markets. The same approach can also be used to disclose whether or not management is too timid in exploiting new sales areas and new products. In many firms, management's figures are arranged to show the rate of pretax profit by sales territories or by products. Now, in each case this figure will always be less than the operating margin, because of the practice of allocating existing rigid expense (overhead) on some pro-rata basis. Note that in EXHIBIT I, for instance, all the profit rates are considerably less than the operating margin, which is 33.88% of production value (see EXHIBIT IV, item 4-b-4). Actually, however, this need not be the case. Up to the *whole* amount of the increase in operating margin could be spent *if necessary* to open a new sales territory or to exploit a new product without causing a cash loss and a drain on profits; any expenditure under this upper limit will add to the firm's pretax profit (in dollars, not as a percentage of volume).

The reason for this is that the old sales areas or old products are already carrying the existing rigid expense or overhead; the addition of a new market or product does not necessarily add to the already existing amount of rigid charges. I realize, of course, that this concept is a heresy to the cost accountant, who tends to insist on "total costs" and on allocating to each new product or new sales territory its share of rigid expense. My rebuttal is that this practice overlooks the fact that a shift of overhead to new products or territories reduces the burden on the old ones and thereby increases the apparent profit on them. What is more, it misleads top management.

Reallocating Sales Effort. Here is another concrete example of what can be achieved in profit gain using the same methods:

A manufacturer of a wide line of textiles sold nationally wanted to discover the cause of the firm's inadequate earnings. He attacked the problem by making an analysis of production value by product lines. For each product line, he assembled his variable manufacturing, administration, and selling costs in the form shown in EXHIBIT IV.

He then classified the different product lines in two groups: (a) those with an operating margin below the company average, and (b) those with an operating margin higher than the company average. The first group accounted for almost two-thirds of total physical volume but for less than one-third of total dollar operating margin.

This situation—not an uncommon one—was clear evidence of misdirection of sales emphasis. Accordingly, top management instructed the sales manager to shift the emphasis from the high unit-volume products to those with the

higher-than-average operating margin. In nine months the firm lifted its pretax profit almost 100%, despite the fact that the physical volume of sales slightly declined.

Advertising Appropriations. In most progressive companies executives are continually coming up with new ideas and schemes. How can they be evaluated? A breakeven point analysis can be extremely helpful in evaluating a proposal from a dollars-and-cents point of view. To illustrate, let me take another instance involving the company in EXHIBIT IV:

The sales manager insisted on an additional $100,000 for advertising. He argued persuasively, as only sales managers can, that the added appropriations "will get us a big increase in volume."

The president took a look at his firm's operating margin (EXHIBIT IV, item 4-b-4). Then he divided $100,000 by 33.88% and came up with $295,159 as the added production value required simply to recoup the $100,000 of added expense, with no profit whatever. In other words, he brought the discussion out of the realm of generalities and down to earth. He went further; he added to the $100,000 a factor of one-third for pretax profit and again divided by 33.88%. The resulting figure, $393,545, showed him the gain in production value needed to justify an extra $100,000 in advertising without violating the company's profit standard.

"See here, Jim," he said, "what do you mean, 'a big increase in volume?' Are you prepared to say you can get as much as $393,545 production value in return?" The sales manager had not thought things through. Confronted with this concrete figure, he backed down.

Labor Demands. One of the prime fallacies of these times is the notion that "we can raise wages because last year's profits were pretty good." The truth is, of course, that there is no way by which last year's profits can be shared in next year's wage rates. No set of figures affords a simple solution to union wage demands, but with a definite standard of the permissible percentage relationship of wages to production value, any firm can quickly find out what it can and cannot do. A problem tends to be simpler when reduced to concrete figures. With them, management can have a constructive wage policy; it can make sound, rational decisions that it can stand on both at the bargaining conference and at the directors' meeting as well. To illustrate again from the experience of the company in EXHIBIT IV:

The union demanded five cents an hour plus "fringes," or a total of seven cents, as "our share of increased productivity." Before saying either "yes" or "no" the management took a look at one of these "clocks." As shown by EXHIBIT IV, item 4-a, standard labor cost was 47.61% of production value. The current performance was 46.18% and hence allowed for *some* wage rate increase. How much? With gross hourly average earnings, including all "fringes," at $1.81, the permitted increase was easily found by the formula:

$$\left[\frac{47.61\%\ \text{(standard)}}{46.18\%\ \text{(actual)}} \times \$1.81\right] - \$1.81 = \$0.056.$$

The permitted increase without exceeding the standard was thus within 1.4 cents of the union demands. With this information, the management could and did reach a settlement without coming to blows. It bargained the union down to the 5.6 cents allowed under the standard.

The examples of policy and planning decisions made with the aid of our business "clocks" by no means exhaust the possibilities. It is perhaps not too much to say that there is scarcely a single move in planning or policy which will not be substantially improved if it is made against the background of such standards as those shown in EXHIBIT III and EXHIBIT IV.

OPERATIONS CONTROL

In the month-to-month control of operating costs and profit, the "clocks" have even more frequent use. They materially improve the executive's capacity for "managing by exceptions" because they show the exceptions in specific dollar amounts, favorable or unfavorable. They make it possible to avoid situations like that in which a certain metal manufacturing firm found itself. It had almost endless records of standard and actual costs by operations and by products. Yet the production manager had no single figure by which his over-all performance could be measured by his superiors. He explained a poor showing by saying, "Well, the volume was down, you know." A good showing, naturally, was due solely to his managerial effectiveness!

By contrast, when the standards for manufacturing are set up like those in EXHIBIT V, the production manager as well as top management can see what ought to happen at any and every level of volume. Variable contingent costs are separated from rigid expense; and when compared to actual variable costs, managerial performance is measurable. No less important is Column F in this exhibit, showing the standard manufacturing margin for each level of volume.

EXHIBIT VI and EXHIBIT VII represent similar control sheets for selling and administration. For top management, EXHIBIT VIII is a simple one-sheet record that reveals monthly any "exceptions" or variance from standard, by major operating functions. To illustrate:

From the right-hand column, top management sees at a glance that the profit for the year to date is, happily, $44,792 (Line 27) over budget (Line 25). What caused that "exception?" Who is responsible? And for how much?

The exhibit itself breaks down the possible sources of the exception into: (1) external causes, i.e., production value under or over budget; and (2) internal causes, i.e., expense under or over. I find it useful and even essential in discussion with associates to keep these two sources entirely separate and distinct. Manufacturing and administrative managers feel no direct responsibility for a short-fall in sales; the sales manager feels no direct responsibility for variances in internal manufacturing and administrative expense.

Keeping this distinction in mind, let us examine the sources of the profit variance. These two items are the key:

1. Line 22, *gain over budget on realized production value*	$21,552
2. Line 23, *reduction in internal expense*	23,240
Total profit variance	$44,792

The first, and larger, amount is traceable to *external* conditions. As Line 21 discloses, the firm's production value was $63,611 over budget; at an operating margin of 33.88%, sales caused a profit gain of $21,552.

The second source of profit gain is traceable to *internal* control. If we break down the single figure of $23,240 (Line 15), we can learn where the gain occurred, who is responsible, and for how much. Thus:

Gain		
Line 6, *manufacturing expense*		$33,136
Short-fall		
Line 9, *selling expense*	$7,548	
Line 12, *administrative expense*	2,348	9,896
Net gain		$23,240

Such a breakdown of the variances serves to fix the responsibility in concrete terms for each of the executives concerned. The problem of *internal* control of expense is not mixed and confused with the problem of overcoming *external* conditions.

Whether the top executive needs or should carry the analysis still further is a matter of individual judgment and preference. For instance, should the sales manager be called upon to show the detail of his excess expense of $7,548, or should it be left to him to correct it in his own way? Either course may be desirable depending on the circumstances. Again, shall the top executive ask for a breakdown of the external variance in production value from budget (Line 21), say, by products, sales territories, or both? It is entirely possible, and in some instances desirable, thus to localize the market factors that led to this gain.

CONCLUSION

How far should the senior executive go in the direction of finer and finer breakdowns? It is probably a matter of his individual judgment and of the capacities of his associates. In general, I find it preferable to avoid too much breakdown; at some not easily determined point it is likely to lift the expense of records maintenance beyond the gain to be had from the use of the information. Moreover, nothing paralyzes action on the part of executives like excessive analysis of figures. This procedure, like anything else, can be carried to extremes; there is a fascination about neatly tabulated figures and charts that needs to be resisted lest it lead managers to believe they are on top of their problems without thinking them through and coming to decisions.

A good general rule, in my experience, is to carry the analysis only far enough to give direction and stimulus to effective action on the part of the managers concerned. For that reason I find it best to begin with only the few and simple charts shown here; these usually are enough to enable the top management to maintain a perspective view of the business and to direct and encourage effective action on the part of managers down the line. In fact, in single-plant operations, these few charts will suffice perhaps indefinitely. In multiplant operations, similar records for each plant are desirable, with a composite set of controls at headquarters.

RECORDS NEEDED

What records are needed to maintain effective control?

With the idea of limiting the number of records to those that can be, and will be, used profitably, I advise starting with two categories:

1. Those records needed for business planning and major policy decisions.
2. Those needed for month-to-month current control of costs and income.

For management planning and easy, close watch on the long-term trend of business developments, the following data showing five years' figures at a glance may be invaluable:

1. Breakeven production value.
2. Safety factor.
3. Date of reaching breakeven.
4. Operating margin.
5. Rigid expense.

EXHIBIT III shows these five master controls in tabular form as prepared for a metal products manufacturer. Of these five, the safety factor index is perhaps the central control which integrates the others. It is well to chart it along the lines of EXHIBIT II. Such a chart reveals at a glance any tendency to expand the rigid expense of added facilities and personnel faster than the realizable growth of the business, or conversely, any failure to keep up with the opportunities of the business. This might almost be termed the *key* to most other management planning decisions. A chart of the trend of the safety factor, along with at least a five-year table of all five master controls, as listed in EXHIBIT III by years, and perhaps by quarters for the current fiscal year, will usually suffice.

For current month-to-month control of costs and income, my experience is that the following limited number of records will adequately serve top-management needs:

1. Four tables showing standards at all levels of production value, above and below breakeven:
   a. Standard total company pretax profit in dollars and expressed as a percentage of production value and of net worth of capital used (EXHIBIT I).

b. Standard total manufacturing costs (EXHIBIT V).
c. Standard total selling expense (EXHIBIT VI).
d. Standard total administration expense (EXHIBIT VII).

2. The following reports each month on standard comparative statement forms, showing the current month and year-to-date figures, which can be easily compared with records of preceding months:

a. Key operating factors (EXHIBIT III).
b. Profit control, with a breakdown to show major operating functions, and reconciliation with budget to show the source of variances (EXHIBIT VIII).

These records usually turn out to be all that are really useful to top management in keeping a month-to-month perspective and having a basis for control. They will be enough to set up EXHIBIT IV, which is the cornerstone of the control procedure advocated in this article (all the other controls and "clocks" are derived from it). Management will then be in a position to measure performance against common standards. Everyone will be able to have the same over-all perspective, and executive teamwork should soon achieve results of a high order.

APPENDIX: DIRECTIONS FOR CONSTRUCTING BREAKEVEN TABLES

During the fiscal year, the total annual and the average monthly costs of certain items of expense change very little or not at all. Examples are real estate taxes, depreciation, property insurance, and executive salaries, among others. Such expenses accrue with the passage of time and do not fluctuate with changes in the volume of business done. They are rigid expenses.

In addition to such expenses, a plant also incurs costs for materials, supplies, power, labor, selling, and other items. The monthly and the annual amounts of such items will vary with the volume of business done, i.e., the amounts are contingent on volume or value of output.

Our problem, therefore, is to separate the conventional accounts into the two categories of rigid expense and variable contingent costs. Our further problem is to state the total annual and the average monthly amounts of rigid expense in single dollar figures: then to state the variable costs in some definite mathematical relationship to the value or volume of business as, for instance, 66.12% of production value.

SEPARATING RIGID AND VARIABLE

To solve the problem of separating rigid expenses and variable costs two approaches are commonly used.

1. *Simple Inspection.* First we may inspect each of our expense accounts and decide which of them represent rigid expense and which represent

EXHIBIT I. PRETAX PROFIT STANDARDS FOR VARYING LEVELS OF OPERATION

(Annual basis)

	Volume as percentage of breakeven (A)	*Volume (production value)* (B)	*Operation costs** (C)	*Pretax profit* (D)	*Profit as percentage of* *Volume* (E)	*Profit as percentage of* *Net worth* (F)
1.	80%	$2,945,173	$3,194,640	$ (249,467)	(8.5)%	(3.5)%
2.	85	3,129,247	3,316,347	(187,100)	(6.0)	(2.6)
3.	90	3,313,320	3,438,954	(124,734)	(3.8)	(1.7)
4.	95	3,497,394	3,559,769	(62,366)	(1.8)	(0.9)
5.	100% (breakeven)	3,681,467	3,681,467	None	0.0	0.0
6.	110	4,049,614	3,924,881	124,733	3.1	1.7
7.	120	4,417,760	4,168,293	249,467	5.6	3.4
8.	150 (addition to surplus)	5,522,201	4,898,535	623,666	11.3	8.6
9.	175	6,442,567	5,507,067	935,500	14.5	12.9
10.	200	7,362,934	6,115,602	1,247,332	16.9	17.2
11.	217 (regular dividend)	7,972,009	6,518,313	1,453,696	18.2	20.1
12.	225	8,283,300	6,724,135	1,559,165	18.8	21.6
13.	230 (extra dividend)	8,467,374	6,845,842	1,621,532	19.2	22.4
14.	235	8,651,447	6,967,548	1,683,899	19.5	23.3
15.	240	8,835,521	7,089,256	1,746,265	19.8	24.1

* Operating costs equal $1,247,332 (rigid expense) plus 66.12% of production value (variable contingent cost); figures rounded.

variable costs. Then these two categories may be listed in separate columns and the columns totaled.

This is a simple method, but unfortunately the facts of business life are not so simply revealed, at least by the conventional arrangements of accounts on most operating statements. At best, only a handful of expense accounts are simon-pure rigid expense or strictly variable contingent costs. For instance, under the heading of manufacturing costs, raw materials, direct labor, and perhaps supplies may be strictly contingent costs—i.e., items rising and falling with the volume or value of output. Depreciation of buildings and equipment, property insurance, and some others, may be strictly rigid. However, such expenses as power, supervisory and engineering salaries, and maintenance will contain elements of both rigid and contingent costs. We cannot separate with sufficient precision the amounts of these two components in each account.

Similarly, under the heading of administration and also under selling expense, we find some strictly contingent accounts, such as cash discounts and sales commissions; we also find some strictly rigid expenses, such as warehouse rentals, bond interest, and cumulative preferred stock dividends. But many other accounts—sales salaries, sales travel, office clerical, and the like—contain elements of both rigid and contingent costs. The two components cannot be separated with accuracy by simple inspection.

2. *Standard Ratios.* Some better method must be applied in order to separate precisely the great majority of accounts into their rigid and contingent components. This calls for constructing a table (or chart, or both) of standard total expense and standard total pretax profit for all levels of volume, such as that shown in EXHIBIT I. The approach needed is mathematical. This is a formidable word and makes the process sound at first somewhat more intricate than it really is. Let me clarify the underlying principle by a homely and familiar example:

In making coffee at home, many wives follow the old formula of one spoonful for the pot and one for each cup to be served; out of habit they allow two cups for each person. If at dinner four people come to the table, the total spoonfuls of coffee (t) required will be easily computed by this formula, where a is the constant one spoonful for the pot, and x is the number of guests:

$$\begin{aligned} t &= a + 2x \\ &= 1 + 2.4 \\ &= 9 \text{ spoonfuls} \end{aligned}$$

The rigid expense in this familiar routine is, of course, "one or the pot" or a; the contingent or variable cost is the fluctuating volume in number of persons or x.

Now, if the nominal head of the household has the temerity to do so, he may prepare a control standard showing the allowable coffee consumption for any meal, and also the average spoonfuls per person. He would

need only to construct a simple table in which the rigid *a* is replaced by 1, and the variable *x* by the number of persons, with the factor 2 remaining constant, as follows:

Number of persons	*Total spoonfuls* ($t = a + 2x$)	*Average spoonfuls per person*
2	$t = 1 + 2 \cdot 2 = 5$	2.50
3	$t = 1 + 2 \cdot 3 = 7$	2.33
4	$t = 1 + 2 \cdot 4 = 9$	2.25
5	$t = 1 + 2 \cdot 5 = 11$	2.20

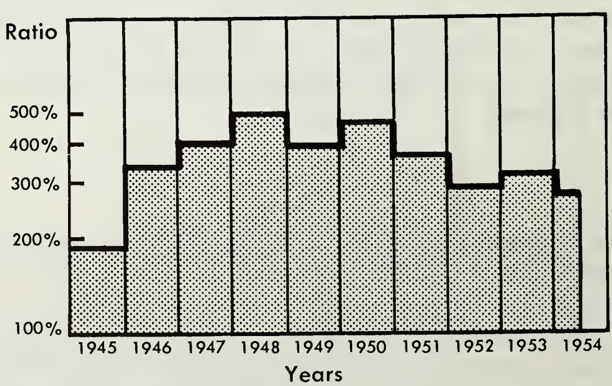
Note that: (1) total coffee used rises and falls with the number of persons (the volume) *but not in direct proportion,* because the rigid "one for the pot" is spread over an increasing (or decreasing) number of persons; (2) the average spoonfuls consumed per person diminishes with an increase in the number of persons, i.e., with a rise in volume, and increases with a decrease in volume.

Executives will immediately recognize the parallel to production: the average *total* cost per order filled or per dollar of production value declines with an increase in volume and rises with a fall-off in volume. This is almost invariably true when *total* manufacturing cost, *total* selling cost, and *total* administration cost are considered. It is likewise true of many individual items comprising these or other categories of expense.

Here, we may note, is the explanation of why the widely used comparison of two periods on a basis of percentages to sales is inaccurate and misleading. *The percentages will change with changes in sales* as well as with the effectiveness of managerial control. And no one can say precisely

EXHIBIT II. THE TREND OF THE SAFETY FACTOR

(Ratio of actual production value to breakeven)



how much of the change is caused by volume changes and how much by improvement or deterioration in managerial effectiveness, unless he is supplied with other data.

For these reasons, the changes in amount of total manufacturing, total selling, and total administration expense cannot be anticipated solely by use of a *uniform* percentage applied to several possible levels of volume or output value. Nor can a pretax profit standard be fixed as a simple and uniform percentage to sales at all levels. As sales increase, the percentage of total expense to sales will almost always decline (because the constant component of rigid expense—or "one for the pot"—is spread over an increasingly larger sales amount), and the percentage of profit will rise. Conversely, on declining sales the total expense percentage nearly always rises and the profit percentage shrinks. The same applies to profit on net worth (capital used), as EXHIBIT I indicates.

Hence, rigid expense must be separately determined with accuracy, so that the remaining *variable* part of any total cost can be stated as a constant percentage of production value at all levels within the range of normal fluctuation.

"LEAST-SQUARES" EQUATION

Fortunately, the mathematicians have worked out equations that are, in the end, quite as simple as the one we have applied to coffee consumption at home. And they have also worked out the method for computing these equations from data available from a firm's regular books. The particular equation most often applicable is that called the "least-squares regression line." It takes the same form as our coffee equation: $t = a + cx$ where t is total expense in any category, a is a constant representing dollar amount of rigid expense, c is a constant percentage, and x is volume or value which may fluctuate from month to month.

In applying this method, it is necessary to arrange in tabular form, in separate columns, the monthly amount of sales or production value and the monthly amount of the expense of a given type, say administration, manufacturing, or a smaller subdivision. Some care may be needed to redistribute over the months of a year expense items that often are charged out when bought or when paid: examples are real estate taxes and property insurance on a three-year premium basis.

When the required tabulations are completed, the least-squares computations are then run out.[2] The end result is to separate total expenses into their two major categories, rigid expense and variable contingent costs.

[2] The computational techniques are not given here. A statistics textbook should be consulted for the procedure.

Whether we want manufacturing costs, sales expense, administrative expense, or total company costs, the least-squares equation expresses the rigid expense in a single dollar figure, and the variable contingent cost as a percentage of whatever production value (or sales) may be obtained. For instance, for the company in EXHIBIT I the equation for figuring total expense (t) is:

$$t = \$1{,}247{,}332 + 66.12\% \textit{ of production value}$$

These items are what the top management needs to know. By substituting in this equation any appropriate dollar amount of production value, multiplying that amount by 66.12%, and adding to the result the $1,247,332 rigid expense, executives can obtain the standard total company expense for particular volumes of business. Thus it is a simple matter to set up a table of standard total company expense for any level of volume.

Measure of Gross Income. What measure of gross income should be chosen? In originating the formula for rigid expenses and variable costs, Knoeppel used net sales, and most other authorities have followed his example. However, sales usually means the invoice value of shipments. It does not mean either orders booked or goods produced. When there is any appreciable time interval between the booking of orders and/or their production and actual shipment, net sales is not by any means a suitable income measure against which to control variable costs.

But there is an even more serious objection to the use of sales values, whether measured by orders booked, goods produced, or goods shipped. Sales value is definitely not a measure of any firm's *internally* disposable income. This is true because it consists actually of two sets of values: (1) the cost of raw materials, power, supplies, and so on, purchased from suppliers and not produced within the firm; and (2) the value of the firm's own productive effort in converting raw materials into its own finished product. Since money spent with suppliers cannot again be spent inside the business, a firm's internally disposable income is obviously limited to the value of its own productive effort, in short, to production value, which is truly 100% of the firm's economic contribution.

Hence, production value is the ultimate limit of all internal business outlays, including corporate income taxes, dividends, and additions to capital account. EXHIBIT IV illustrates this basic concept, beginning with Line 3. (Controllers will recognize here, as elsewhere in this article, the so-called "marginal income" type of accounting often applied to individual products or product lines.) I have yet to see a business in which management thinking and decisions are not substantially benefited by controlling internal costs and expenses strictly according to this one significant factor—production value.

EXHIBIT III. FIVE-YEAR TRENDS OF KEY OPERATING FACTORS

	1949	*1950*	*1951*	*1952*	*1953*
Actual volume (production value)	$4,495,209	$7,270,095	$7,090,617	$5,283,111	$6,310,016
1. Breakeven volume (production value)	$1,091,558	$1,528,795	$1,896,166	$1,771,231	$2,007,668
2. Safety factor: actual volume as percentage of breakeven	411.82%	475.54%	373.94%	298.27%	314.30%
3. Date of reaching breakeven point	March 31	March 19	April 8	May 3	April 27
4. Operating margin	35.44%	32.71%	31.79%	31.94%	30.31%
5. Fixed or rigid charges	$ 386,848	$ 500,069	$ 602,791	$ 565,731	$ 608,524

EXHIBIT IV. SPECIMEN OPERATING STATEMENT SHOWING RIGID AND VARIABLE CONTINGENT COSTS

	Rigid expense	*Variable costs*	
1. Sales value of output			168.00%
2. Deduct: raw materials, supplies, etc.			68.00
3. Production value realized			100.00%
4. Disposition of production value:			
(a) Labor's share of production		47.61%	47.61%
(b) Management's margin over labor costs			
1) Manufacturing burden (EXHIBIT V)	$1,083,093	4.37%	
2) Selling expense (EXHIBIT VI)	65,695	5.66	
3) Administration expense (EXHIBIT VII)	98,544	8.48	
Subtotal, all expense in margin	$1,247,332	18.51%	52.39%
4) Operating margin, available for rigid expense and then profit		33.88%	
			100.00%

MANAGEMENT GOALS		PRODUCTION VALUE REQUIRED	(cumulative)
1. Breakeven point	$\frac{\$1{,}247{,}332 \text{ rigid expense (above)}}{33.88\% \text{ operating margin (above)}}$	$3,681,467	$3,681,467
2. Add: regular dividend and increased surplus	$\frac{\$1{,}453{,}696 \text{ pretax profit}}{33.88\% \text{ operating margin}}$	$4,290,542	$7,972,009
3. Add: extra dividend	$\frac{\$167{,}997 \text{ pretax profit}}{33.88\% \text{ operating margin}}$	$ 495,365	$8,467,374

EXHIBIT V. STANDARD MANUFACTURING COSTS AT VARYING LEVELS OF VOLUME

(Annual basis)

	Volume as percentage of breakeven (A)	Volume (production value) (B)	Manufacturing costs allowable at standard Variable* (C)	Rigid (D)	Total (E)	Manufacturing margin† (F)
1.	80%	$2,945,173	$1,530,754	$1,083,093	$2,613,848	$ 331,325
2.	85	3,129,247	1,626,427	1,083,093	2,709,520	419,727
3.	90	3,313,320	1,722,099	1,083,093	2,805,192	508,128
4.	95	3,497,394	1,817,771	1,083,093	2,900,864	596,530
5.	100% (breakeven)	3,681,467	1,913,444	1,083,093	2,996,537	684,930
6.	110	4,049,614	2,104,789	1,083,093	3,187,882	861,732
7.	120	4,417,760	2,296,134	1,083,093	3,379,227	1,038,533
8.	150	5,522,201	2,870,165	1,083,093	3,953,258	1,568,943
9.	175	6,442,567	3,348,526	1,083,093	4,431,619	2,010,948
10.	200	7,362,934	3,826,888	1,083,093	4,909,981	2,452,953
11.	217	7,972,009	4,143,449	1,083,093	5,226,542	2,745,467
12.	225	8,283,300	4,305,249	1,083,093	5,388,342	2,894,958
13.	230	8,467,374	4,400,922	1,083,093	5,484,015	2,983,359
14.	235	8,651,447	4,496,593	1,083,093	5,579,686	3,071,761
15.	240	8,835,521	4,592,265	1,083,093	5,675,358	3,160,163

* Variable costs are 51.98% of production value in Column B; figures rounded.
† Column B minus Column E.

EXHIBIT VI. STANDARD SELLING EXPENSE AT VARYING LEVELS OF VOLUME

(Annual basis)

	Volume as percentage of breakeven (A)	Volume (production value) (B)	Selling expense allowable at standard Variable* (C)	Rigid (D)	Total (E)
1.	80%	$2,945,173	$166,622	$65,695	$232,317
2.	85	3,129,247	177,035	65,695	242,730
3.	90	3,313,320	187,450	65,695	253,145
4.	95	3,497,394	197,863	65,695	263,558
5.	100% (breakeven)	3,681,467	208,277	65,695	273,972
6.	110	4,049,614	229,105	65,695	294,799
7.	120	4,417,760	249,931	65,695	315,626
8.	150	5,522,201	312,415	65,695	378,110
9.	175	6,442,567	364,483	65,695	430,178
10.	200	7,362,934	416,553	65,695	482,248
11.	217	7,972,009	451,013	65,695	516,708
12.	225	8,283,300	468,622	65,695	534,317
13.	230	8,467,374	479,035	65,695	544,730
14.	235	8,651,447	489,449	65,695	555,144
15.	240	8,835,521	499,864	65,695	565,559

* Variable costs are 5.66% of production value in Column B; figures rounded.

EXHIBIT VII. STANDARD ADMINISTRATIVE EXPENSE AT VARYING LEVELS OF VOLUME

(Annual basis)

	Volume as percentage of breakeven (A)	Volume (production value) (B)	Administrative expense allowable at standard: Variable* (C)	Rigid (D)	Total (E)
1.	80%	$2,945,173	$249,931	$98,544	$348,475
2.	85	3,129,247	265,553	98,544	364,097
3.	90	3,313,320	281,173	98,544	379,717
4.	95	3,497,394	296,794	98,544	395,338
5.	100% (breakeven)	3,681,467	312,414	98,544	410,958
6.	110	4,049,614	343,656	98,544	442,200
7.	120	4,417,760	374,896	98,544	473,440
8.	150	5,522,201	468,623	98,544	567,167
9.	175	6,442,567	546,726	98,544	645,270
10.	200	7,362,934	624,829	98,544	723,373
11.	217	7,972,009	676,519	98,544	775,063
12.	225	8,283,300	702,932	98,544	801,476
13.	230	8,467,374	718,553	98,544	817,097
14.	235	8,651,447	734,174	98,544	832,718
15.	240	8,835,521	749,795	98,544	848,339

* Variable costs are 8.48% of production value in Column B; figures rounded.

EXHIBIT VIII. EXAMPLE OF PROFIT CONTROL BREAKDOWN

		Current month	*Cumulative for year*
	Production Value		
1.	Sales Value of Output	$1,312,466	$8,662,276
2.	*Less:* Materials and Supplies	698,888	4,612,661
3.	*Production Value*	$ 613,578	$4,049,615
	Performance to Budget		
	Manufacturing Costs		
4.	Standard	$ 409,196	$2,646,538
5.	Actual	408,344	2,613,402
6.	Variance from Standard	$ 852	$ 33,136
	Selling Expenses		
7.	Standard	$ 40,203	$ 262,052
8.	Actual	42,125	269,600
9.	Variance from Standard	$ (1,922)	$ (7,548)
	Administrative Expenses		
10.	Standard	$ 60,243	$ 392,679
11.	Actual	61,723	395,027
12.	Variance from Standard	$ (1,480)	$ (2,348)

	Total Costs and Expenses		
13.	Standard	$ 509,642	$3,301,269
14.	Actual	512,192	3,278,029
15.	*Variance from Standard*	$ (2,500)	$ 23,240
	Pretax Profit		
16.	Standard	$ 103,936	$ 748,346
17.	Actual	101,386	771,586
18.	*Variance from Standard*	$ (2,550)	$ 23,240
	BUDGET COMPARISONS		
19.	Budget Production Value	$ 664,334	$3,986,004
20.	Actual Production Value	613,578	4,049,615
21.	*Variance from Budget*	$ (50,756)	$ 63,611
22.	Resulting Profit Variance (33.88% of Line 21)	$ (17,196)	$ 21,552
23.	Cost-Expense Variance (Line 18)	(2,550)	23,240
24.	*Total Profit Variance*	$ (19,746)	$ 44,792
	RECONCILIATION		
25.	Profit Required at Budget	$ 121,132	$ 726,794
26.	Actual Profit (Line 17)	101,386	771,586
27.	*Total Profit Variance*	$ (19,746)	$ 44,792

It is to be preferred for practical as well as theoretical reasons. For instance, labor unions have come to demand an equitable "share of increasing productivity" as a part of their members' earnings. Production value supplies a true measure of "productivity" in the simplest and most useful manner I have yet discovered. Moreover, total payroll costs of hourly rated factory labor (direct and indirect, with overtime and premium payments and "fringes") tend to bear a near-constant relationship to production value. Thus there is a basis for comparing this year's payroll with former years' despite changing levels of prices and productivity.

To attempt to relate wages (or other variable contingent costs) to sales values invoiced or produced provides no sound basis for evaluating labor's demands. The practice rests upon the curious assumption that, somehow or other, material costs should maintain a constant percentage to sales values. Such can be the case in certain special situations; it is more often not the case, however, especially today when firms are changing from low-price to higher-price materials, and sometimes making subassemblies but at other times buying them. (Of course, far too many firms continue to price their products in such a way as to cause the material-cost component to whipsaw margins and pretax profits. Such pricing methods need considerable overhauling. But that is another story.) Besides, what is the

point of paying labor, salesmen, and others a commission on raw material costs necessarily included in sales values of output or shipments?

SETTING UP CONTROL STANDARDS

It is now easy enough to set up five master control standards, as in EXHIBIT III. For instance, when variable contingent costs are expected to absorb 66.12% of any amount of production value (taken as 100%), then only 33.88% remains as the operating margin.

The operating margin is of overwhelming significance; it is certainly one of the five most important figures in any business. In this example, it is 33.88% of production value, and is the only part of production value which can be used to pay rigid expense. In other words, we can make no profit until all rigid expense has been covered out of this 33.88% of production value.

How much production value is needed to cover $1,247,332 of rigid expense, and thus just break even? Obviously an amount which when multiplied by 33.88% will yield exactly $1,247,332:

$$\$1{,}247{,}332 \div 33.88\% = \$3{,}681{,}467$$

But this is just a beginning. No one intends to be merely a "nonprofit" organization. If we are to make any profit this year, we must certainly do more volume than $3,681,467. Therefore, we come naturally to this conclusion, and it is a highly important one: *We must generate the breakeven volume sometime before the end of the fiscal year, or there will be no profit.*

At what date before the end of the fiscal year should production value begin to exceed the breakeven point? This is the question which writers on this subject have neglected; in my experience it is a genuinely key point. Until it is answered, we cannot really have a true plan; we have only an objective but no time schedule for achieving it. Hence, we not only must set out to exceed the breakeven point, but must seek to do it at the earliest date which is reasonable in the light of current conditions. In my experience, it is more vital to have all executives in an organization striving to shorten the number of months needed to break even than it is to have their eyes on some profit goal. For, once a firm has covered, in the first four, five, or six months of the fiscal year, *its entire yearly rigid expense,* profit follows almost as surely as water runs downhill.

In EXHIBIT III, then, the most probable date of passing the breakeven point is included (Line 3). This date serves to integrate time with volume, and to show the entire top management not only what is to be done but by what time.

Let us go on to another significant use of the operating margin percentage and of the breakeven point—forecasting the total production value needed to earn any stated amount of pretax profit. Suppose we want

$1,000,000. I like to regard such a profit target as actually a "rigid expense" of the business, since a part of it is, in effect, the cost of financing business growth and progress in the future. The remainder pays the owners for the use of their capital and for their income taxes. To obtain the amount of production value required for any amount of pretax profit, only two simple steps are needed: (1) add the pretax profit to rigid expense and (2) divide the sum by the operating margin percentage. The result tells the executive, his associates, and his board of directors what it takes in volume to earn a normal return on net worth, to pay regular dividends, to pay "extras," and to provide any other funds which were included in the $1,000,000. Thus the volume in production value needed is:

$$\frac{\$1{,}247{,}332 + \$1{,}000{,}000}{33.88\%} = \$6{,}633{,}211$$

We can also compute the percentage of our actual volume to breakeven volume and find the safety factor (Line 2, EXHIBIT III). This factor tells us how much volume we can lose before going "into the red." In fact, almost anything an executive wants to know about the operating economics of his business can be learned readily by the use of breakeven point controls.

33. THE LEARNING CURVE AS A PRODUCTION TOOL

Frank J. Andress*

As a new product continues to be produced in a consistent fashion the improvement in labor efficiency can be predicted. The "learning curve" device has been developed to aid in the intelligent use of this in planning.

Practically every manufacturing company has to forecast labor time and cost per unit of product in order to set selling prices, plan delivery schedules, calculate capital and labor needs, and so on. For years forecasting labor input has been a laborious and time-consuming job. Now, with the aid of a new concept developed by the aircraft industry in World War II—the learning curve—such forecasting should become much easier, quicker, and more accurate.

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* From *Harvard Business Review,* XXXII, 1 (1954), 87-97. Reprinted by permission of the *Harvard Business Review.*

That the learning curve concept can be applied readily to common types of manufacturing operations outside aircraft is illustrated dramatically by the following incident:

> During World War II an executive of a home-appliance manufacturing company chanced to cross paths with an executive of a large West Coast aircraft firm. The appliance executive mentioned that it had taken his company two years to determine the exact cost of the electric refrigerator which it manufactured.
>
> The aircraft executive pointed out that in many cases his company had been forced to determine costs on similar items in a matter of a few minutes, and said, "I'll bet you a steak dinner that I can predict the cost of your 100,000th refrigerator within 10% accuracy by using a learning curve based on aircraft production."
>
> The manufacturing executive accepted the bet. The only information he furnished was the weight of the refrigerator and the cost of the first unit produced. During the next few minutes he watched while the aircraft executive worked with pencil, ruler and log-log graph paper.
>
> When he had completed plotting the curve, the aircraft executive stated: "Your 100,000th unit should cost you $162.50."
>
> "Just drop the 50 cents," the appliance executive said. "It was actually $162.00."

In the following pages, I should like to explain how the learning curve works, point out some of the problems that it poses, and discuss its potential applications in different industries.

THE THEORY

The basic theory of the learning curve is simple: a worker learns as he works; and the more often he repeats an operation, the more efficient he becomes, with the result that the direct labor input per unit declines. This holds true whether the industry is aircraft, metalworking, textile, or candy-making. What was not known until a decade ago is that the rate of improvement is regular enough to be predictable. It is this fact that makes what would otherwise be a rather commonplace observation the clue to a broader and more practicable concept for business.

DEVELOPMENT

Even before the Second World War, when the theory came into general use in the aircraft industry, it had been recognized that the direct labor input per airplane declined with considerable regularity as the cumulative number of planes produced went up. (Because of the high unit costs of a fuselage or complete plane, a phenomenon of this sort would naturally be *more conspicuous* in the case of aircraft than of most other industries.) Not only did this mean that the unit cost progressively declined; but of more importance, particularly in wartime, it meant that more planes could be produced with the same work force and facilities.

This reduction in labor time per unit might have been called rising productivity. On the other hand, the process repeated itself whenever a new type of plane was put into production; that is, the direct labor input reverted back to approximately what it had been when the first plane of the preceding type was put into production (assuming the two plane types were of similar size and configuration). The phenomenon was referred to as learning because of this repetitive characteristic, rather than as productivity which implies some sort of sustained improvement.

Regardless of the label used, the significant fact is that the learning pattern occurred with considerable regularity. It was not long before the various airframe companies had established certain standards of learning which they used as a basis for predicting direct labor input. Then the armed services became interested and sponsored a statistical study of direct labor input by the Stanford Research Institute covering a majority of all aircraft produced in the Second World War. (The industry lent itself well to such a study because most aircraft companies operate on a job-shop basis of cost accounting, which lessens the task of obtaining the necessary data.)

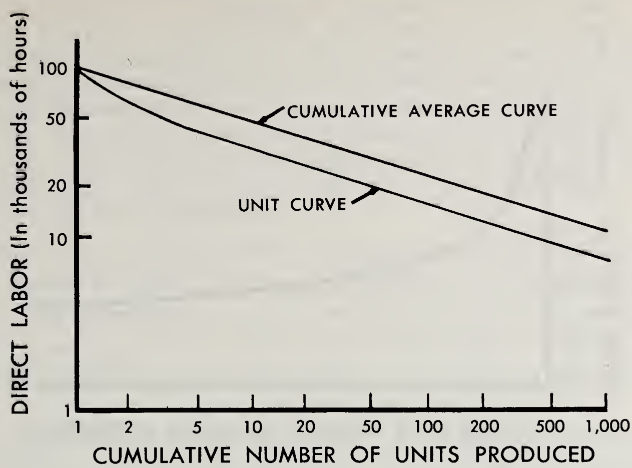
As a result, there was developed a series of learning curves which represented the *average* experience for various categories of airframes—fighters, bombers, and so forth. Although these curves were all different in terms of their starting points (i.e., the labor input for the first plane of a particular type), the great majority had one characteristic in common: their *rate* of improvement. It was this fact, essentially, that started speculation about a general theory of learning curves.

The rate of improvement which was found to hold true for the operations covered by the survey was such that, once production on a plane got going, the 4th unit required about 80% as much direct labor as the 2nd; the 10th, 80% as much as the 5th; the 200th, 80% as much as the 100th; and so forth—in each case a reduction of 20% between doubled quantities. Because this *rate* of improvement seemed to prevail so consistently, it was concluded that the aircraft industry's rate of learning was approximately 80% between doubled quantities. That standard is applied to this day in analyzing a variety of procurement, production, and costing problems within the industry and within particular companies.

HYPOTHETICAL CURVE

So that the reader may obtain a better picture of the learning curve, a hypothetical one is reproduced in EXHIBIT I. Here we see two lines drawn on log-log graph paper such that the 20% reduction holds true between all doubled quantities (except for a small distortion at the upper end). The lower line represents the unit curve (the direct labor hours for a particular unit) while the upper line represents the cumulative average

EXHIBIT I. HYPOTHETICAL LEARNING CURVE ON LOG-LOG GRAPH PAPER

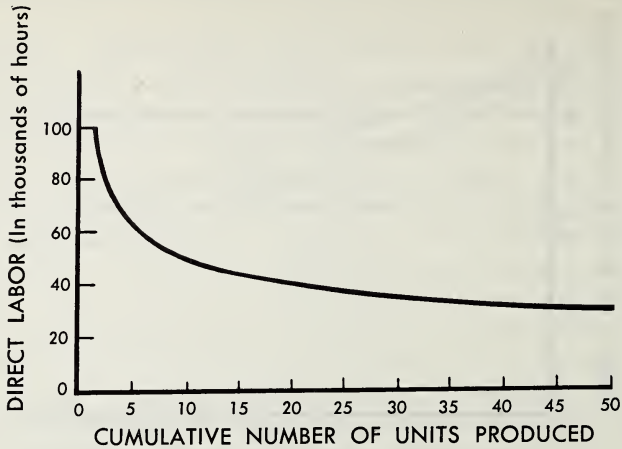


curve (the average direct labor hours for all units produced up to any particular point). Thus the unit curve indicates that the 100th airframe should require approximately 15,600 hours, whereas the average for the first 100 airframes produced should be approximately 23,000 hours. These two lines can, of course, be expressed mathematically. There are three learning curve formulas:

(1) $Y = KX^n$, where:
  Y = cumulative average man-hours for any number of units,
  K = number of man-hours to build first unit,
  X = any number of completed units, and
  n = log (% of learning curve) ÷ log (2).
  [Note that the exponent n will always be a negative number unless the slope is 100%. Such a negative exponent can be handled as follows: $x^{-n} = 1 \div x^n$.]
(2) $U = (n + 1)KX^n$, where:
  U = unit man-hours for a specific unit, and all other symbols are the same as above.
  [$(n + 1)$ is referred to as the conversion factor, and for an 80% curve: $(n + 1) = + 0.67807$.]
(3) $T = KX^n(X)$, where:
  T = total man hours required to build a predetermined number of units, and all other symbols are the same as above.

The cumulative curve in EXHIBIT I appears as a straight line because of the nature of log-log graph paper. (So does the unit curve after its initial jog.) A learning curve is usually drawn on log-log paper simply because in straight-line form it is much easier to project.

EXHIBIT II. CUMULATIVE AVERAGE CURVE ON ORDINARY GRAPH PAPER



If the same curve were drawn on ordinary graph paper it would become a true "curve," as EXHIBIT II indicates. This curve, of course, more dramatically illustrates the absolute amounts of reduction from one unit to the next. Thus, though the *percentage* of reduction remains the same, it applies to a progressively diminishing base, and the absolute amounts become less and less until they virtually level off. This reflects the fact that in actual experience the process of learning a given operation eventually approaches a plateau where relatively little further improvement takes place.

CAUSAL FACTORS

What factors account for the learning curve phenomenon? A distinction must be made between (a) learning in the literal sense, on the part of both workers and management, but primarily the former, and (b) a whole series of other factors, among which management innovations appear most significant. These causal factors operate sometimes in combination and at other times in opposition. To this extent, the learning curve is more of an empirical method for charting all the various forces which work on labor hour input than it is a truly scientific device.

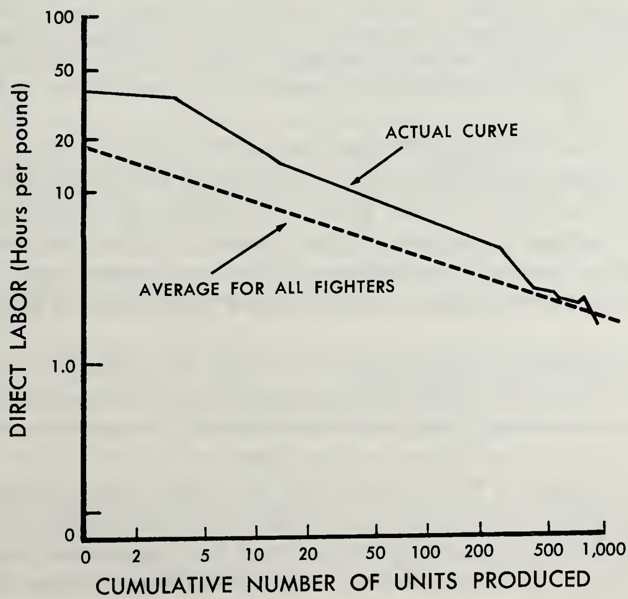
The significant fact is the consistent behavior of the curve, which indicates that of the various factors learning in the literal sense is the predominant influence. It results in a smooth pattern of labor hour reduction, whereas the other factors can be erratic. Moreover, the more opportunities there are for learning, the steeper the curve, as the experience of the aircraft industry demonstrates:

Approximately 75% of the total direct labor input in the industry is assembly; the balance is represented by machine work. In assembly work there is a relatively large scope for learning; in machine work the ability to reduce labor hours is greatly restricted by the fact that the machines cannot "learn" to run any faster. Accordingly, when the proportion of assembly work is less, the reduction of labor input is slower. For example, in the case of operations made up of approximately three-quarters machine time and one-quarter assembly time (the reverse of the usual situation in the aircraft industry), the approximate rate of learning has been found to be 90% rather than 80%. That is, the labor hours drop only 10% between doubled quantities, compared with 20% for the industry generally.

Of course the nonlearning factors do have some influence. That is why learning curves in reality are not as smooth as the hypothetical one in EXHIBIT I. For example, new machinery introduced by the company will bring about savings in labor hours; so may time studies or design changes. The result will be to give a jerky effect to the curve, as EXHIBIT III illustrates.

The irregular line is the actual learning curve experienced in the production of a certain type of fighter plane, whereas the straight line is the industry average for all fighters established by the Stanford Research study (in this instance expressed in hours per pound of airframe). The

EXHIBIT III. ACTUAL CURVE FOR WORLD WAR II FIGHTER VERSUS AVERAGE OF ALL FIGHTERS



actual curve is quite smooth until the 250th plane; it has a slope of approximately 77½%, which corresponds closely with 78½%, the industry average for this particular type of plane. After the 250th plane, however, it drops off sharply. The implication is that learning in the literal sense was predominant in the beginning (or else a whole variety of other factors canceled each other out very neatly); but subsequently other factors entered the picture, and the curve became quite unpredictable.

THE HAZARDS

There is no sure-fire accuracy about the learning curve. If management *is* to get accurate forecasts with it, certain pitfalls and limitations must be recognized.

ILLUSORY SAVINGS

Perhaps the greatest need for caution is in the selection of labor hour data to be used in plotting the curve. For instance:

1. How is increased utilization of purchased parts to be handled? If a manufacturer receives a larger portion of his raw material in a finished state, his labor input per unit should decline. However, the decline is merely the result of shifting labor input from his plant to that of his supplier, and it would be erroneous to show the decline as a real reduction in the labor input per unit. The same work is being performed in total, and no *net* saving has been realized.
2. Similarly, it might be possible to generate a direct labor reduction of 1,000 hours by spending 10,000 hours on additional tooling and engineering. Of course there would be no real saving as a result. Clearly, therefore, direct labor hours cannot be considered as separate from the changes in the other elements of cost.

There is also the danger of labor "savings" resulting from a mere reshuffling of the accounting records. The learning curve plots direct labor only. But what happens when greater use is made of supervisory labor, which is classified as indirect? If the emphasis is placed on direct labor savings alone without considering overhead and, particularly, indirect labor, a very distorted picture of direct labor productivity is likely to result.

Another problem to watch out for is that of a change in the labor "mix." By hiring more skilled and correspondingly more expensive workers, a manufacturer may bring about a reduction in direct labor *hours* only to face the irony of an increase in direct labor *cost.*

Finally, changes in direct labor hours may result from changes in the rate of production. If the rate of production is increased from below "normal" levels to, say, 90% of capacity, it may be possible to organize the work force in a more efficient manner and thereby reduce the labor

input per unit. In other words, there is the possibility that a decline in the direct labor input per unit may be due almost entirely to increased volume, not to "learning."

The point of all this is that the computation of learning curves is subject to many hazards. There are technical methods for taking these hazards into account and compensating for them; there is no great difficulty on that score. But from the management viewpoint there is a real problem in the constant need to be on guard against errors creeping into the data for the learning curve and distorting it. The responsibility for this rests with the executives in the control function, collaborating with accountants, plant superintendents, and industrial engineers.

VERIFICATION

That these hazards were avoided in the study of the aircraft industry's experience—in other words, that the 20% reduction in labor hours between doubled quantities was not merely the result of inaccurate compilation of data or of a failure to isolate accurately the factors which actually produced the reduction—is indicated by the following points:

1. The direct labor input data measured consisted not only of direct labor performed by the prime contractors, defined as on-site, but of labor performed by subcontractors as well, defined as off-site. In other words, insofar as possible the *total* labor input was measured rather than merely the prime contractor's labor input, thereby avoiding any apparent savings resulting from the increased utilization of purchased parts by the prime contractors.

To be sure, the measurement of *total* labor input is practically an impossible task when routine standard parts must be accounted for. Thus, a subcontractor using 1,000 ordinary washers may have manufactured them or procured them from a local mill supply house. Nevertheless, it is fair to assume that over short periods of time, such as six months, the type and the quantity of standard parts used (e.g., the washers) would not vary greatly; so that, whether the practice were to buy or manufacture them, the figures used to compute the learning curve would not be affected first one way, then the other, during the period.

2. We know that time studies were used to check similar operations—especially the important assembly operations—at different periods in the learning cycle. These time studies indicated a pattern similar to that shown in EXHIBIT II.

3. Purchasing agents, production managers, methods engineers, and accountants in the aircraft industry have applied the learning curve principle for ten years now. Presumably these men would have discovered the "joker," if there were one, in this period of time. Significantly, its use has steadily increased in recent years.

4. It is difficult to account for direct labor hour savings because of other factors—for example, excessive expenditures on tooling and engineering. Yet in a profit-and-loss economy it is hardly likely, for instance, that a manufacturer would intentionally spend $500,000 on excessive tooling in order to effect a $100,000 reduction in direct labor.

All factors considered, the learning curve seems to have stood the test of time in the aircraft industry as a valid, reasonably accurate method of forecasting direct labor requirements. The fact remains that it cannot properly be called—at least in its present state—a scientific tool. It may one day become that, however, and in the meantime there is the prospect that it can continue to serve management quite usefully in its present form.

THE USES

Some of the specific ways in which management in a wide variety of industries can use the learning curve—from getting new help on "make or buy" decisions to planning closer delivery schedules—are apparent from the experience of companies in and associated with the aircraft industry. A discussion of these uses will doubtless suggest others to readers.

IN PRICING

The learning curve is continually used by the Air Force, Navy, and aircraft companies to forecast direct labor hours for a predetermined number of airframes as a basis for negotiating prices. Here are two illustrative cases (the real names of the companies cannot be used):

The Standard Aircraft Company. This company had just finished constructing 221 airframes under a postwar contract with the Air Force. Its actual learning curve, authenticated by an audit, was as shown by the solid line in EXHIBIT IV. The 221st ship required about 17,750 hours (2.42 hours per pound, the figure indicated by the curve, times 7,334, the number of pounds per airframe).

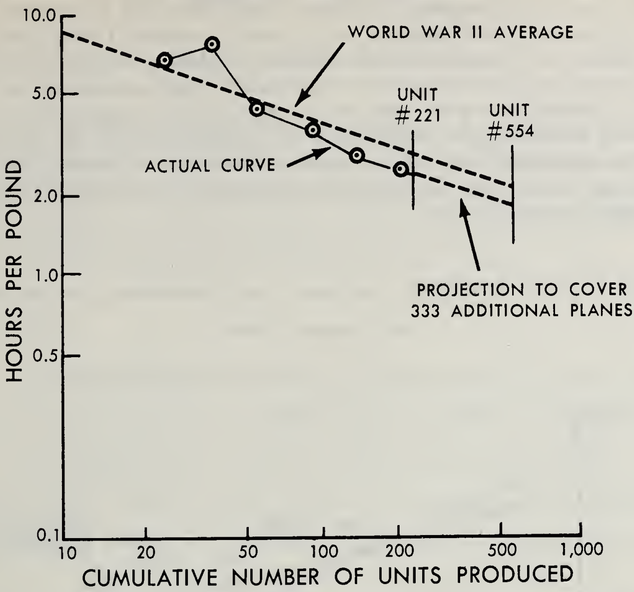
At this point the Air Force wanted to purchase another 333 airframes of exactly the same type. The question was not whether to use a learning curve, but rather which one of two would be better—the original curve based on World War II experience that had been used to price the original contract (see the broken line) or a new one based on a continuation of the figures for the 221st plane. Because the World War II curve would have produced an average of 17,730 hours for the 333 additional planes—obviously too high since the actual record had already reached almost the same figure for the 221st plane—the decision was made to drop it and instead to project a new 80% curve from the 221st plane to the 554th on the assumption that the rate of learning would continue during the production of the additional 333 planes.

On this basis, an average of 14,660 hours was obtained for the 333 planes. The figure finally agreed upon between the two parties was 14,450 hours (a small change in design being computed separately).

The Webster Machine Company. Following the outbreak of the Korean War the Army's own facilities were inadequate to meet the demand for gun barrels. Accordingly, the work was "farmed out" to private companies, one of which was the Webster Machine Company.

The contract called for a single rough boring operation on 2,000 gun barrels; in other words, machine time (rather than assembly time) represented a large

EXHIBIT IV. LEARNING CURVE FOR 221 PLANES MANUFACTURED BY STANDARD AIRCRAFT COMPANY



part of the work. The initial contract price was \$76.70 per unit subject to price redetermination. When the price was redetermined, Webster had completed 545 units at an average direct labor cost, verified by audit and time study, of 35.3 hours per unit. What direct labor cost should be charged in computing the price for the uncompleted units? Both parties recognized the fact that the 35.3-hour figure was too high for the contract as a whole and that because of some sort of learning factor or increase in the contractor's "know-how," the new figure should be lower.

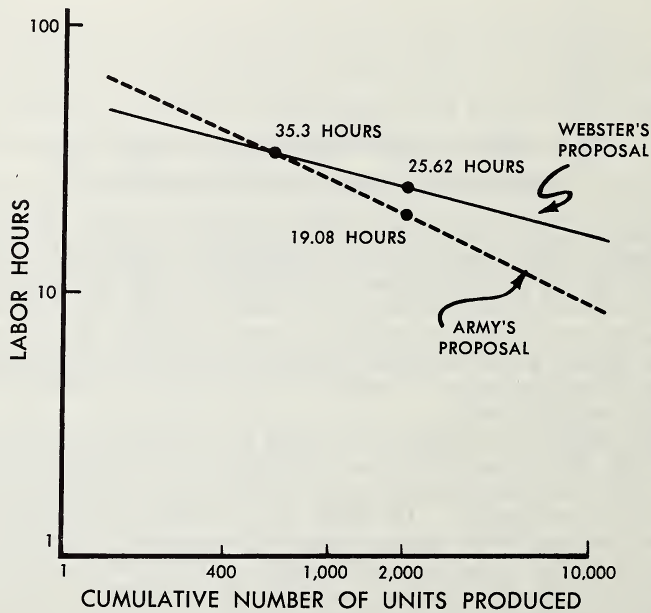
Webster argued for 22 hours per unit for the uncompleted units, pointing out that the Army had seven years' experience in this operation whereas Webster had never done it before. EXHIBIT V shows the company's proposal in the form of a learning curve. The figure of 35.3 hours was recognized as the cumulative average for the first 545 units and, accordingly, was plotted as one point on the graph. To get the second point, which was necessary in order to construct the curve, the company computed the cumulative average for all 2,000 units (including the 545 produced to date) on the basis of 22 hours per unit for the uncompleted units; and thus arrived at an over-all average of 25.62 hours. A straight line drawn between the points had a slope, or rate of learning, of 85% between doubled quantities. Applying the conversion factor for an 85% curve, which is 0.766, to the 25.62 average for all 2,000 units, it appeared that the direct labor theoretically required for the *last* unit, according to Webster's proposal, was 19.6 hours (25.62 × 0.766 = 19.6 hours).

The Army supply officer took a very different view. He argued that since the Army was performing the operation itself in 11.6 hours, 13 hours was a fair figure for the uncompleted units. (Webster did not possess the Army's

special hoists.) His proposal, which was computed in the same manner as Webster's, is also shown in EXHIBIT V. The slope of his line was a phenomenal 71.5%. In order to obtain the cumulative average of 19.08 hours for all 2,000 units called for by his proposal, Webster would have had to produce the last unit in 9.82 hours (19.08 hours × 0.515, the conversion factor for a 71.5% slope). This was 1.78 hours *less* than the time the Army was taking to produce the gun barrels, and the Army had seven years' more experience on the job.

Clearly, Webster's proposal was the more reasonable, especially in view of the fact that machine time represented the greater part of the work which, judging from experience elsewhere, meant a slower rate of learning (or a higher percentage of labor time required between doubled quantities). The parties finally agreed on an 85% curve.

EXHIBIT V. WEBSTER COMPANY AND ARMY COUNTERPROPOSALS IN THE FORM OF LEARNING CURVES



Calculations:

Webster—

545 units @ 35.3 hours = 19,238 hours
1,455 units @ 22 hours = 32,010 hours

51,248 hours

51,248 ÷ 2,000 = 25.62 hours

Army—

$$
\begin{array}{rl}
545 \text{ units @ } 35.3 \text{ hours} = & 19{,}238 \text{ hours} \\
1{,}455 \text{ units @ } 13 \text{ hours} = & \underline{18{,}915 \text{ hours}} \\
 & 38{,}153 \text{ hours} \\
38{,}153 \div 2{,}000 = & 19.08 \text{ hours}
\end{array}
$$

Of course in many applications the usefulness of the learning curve for pricing decisions can be extended even beyond the important element of direct labor costs. To the extent that labor charges form the basis for *allocating* other costs, the curve also will serve as a guide to determining factory overhead, general and administrative expense, and so on.

MAKE OR BUY

Make or buy problems are common to practically all manufacturing industries. The decisive issue is usually an economic one—whether it is cheaper for the company to make an item itself or procure it from the outside. The learning curve can be a helpful device for resolving such an issue, particularly when buying means subcontracting or ordering on a negotiated price basis. To illustrate (again with company names disguised):

Early in 1952 the Lee Aircraft Company was faced with a cutback in its production as a result of the Air Force stretch-out program. Consequently, it was inclined to cancel some of its subcontracts and pull the work back into its own shop to keep it fully occupied.

One subcontract which it thought of canceling was with the Roberts Manufacturing Company for 372 landing flap assemblies—an item which it also was manufacturing in its own plant. To arrive at a comparison of its own and Roberts' costs of manufacturing the assemblies, Lee decided to plot the respective learning curves.

Lee had already produced 165 assemblies, with a figure of 445 hours for the 165th unit, and was well along the downward slope of its learning curve; continuation of the curve indicated a total labor input of 111,000 hours for 372 additional units. In comparison, the Roberts Company, while apparently a more efficient producer of the item, was just getting started on its learning curve; if it went on, it would be able to produce the 165th unit at an expenditure of 402 hours—43 hours less than Lee—but continuation of its curve from the earlier, higher point *at which it then was* indicated a total labor input of 164,000 hours for the 872 units, or 53,000 more than Lee.

The foregoing analysis served to pinpoint the question for management's judgment. In the short run, it was more economical for Lee to cancel the subcontract and do the work itself. In the long run, however, it would be less expensive to leave the work with Roberts inasmuch as it could produce the landing flaps for about 10% less labor since it had got as far out on its learning curve as Lee. Therefore, the decision hinged largely on the probable total future demand for landing flaps of this type. Since this total future demand

was difficult to measure, Lee decided to take advantage of the direct labor savings offered at the time, which amounted to over $300,000. Accordingly, it canceled the contract with Roberts.

IN PRODUCTION

The time required to perform an operation or a whole series of operations is a vitally important factor in management decisions about production equipment, number of workers, work flow, production control, and practically every other aspect of production. Since the learning curve is a means of forecasting the time required, it can often be a helpful tool.

Perhaps its simplest and most obvious use is in forecasting output. For example, if the size of the work force is kept constant, the declining trend of labor hours resulting from learning will result (assuming that materials and purchased items are available on schedule) in a rising trend of deliveries. If, say, in March the average direct labor per plane is 20,000 hours, and by May it is down to 15,000 hours, then a work force of 2,000 people working a total of 400,000 hours a month can supposedly produce 20 planes in March and 26.7 planes in May. If changes in the work force are anticipated, they can of course be taken into consideration and the forecast altered accordingly.

A more complicated but no less important use of the learning curve is in situations where sales are fluctuating and management needs to plan the proper size of the work force in advance. Here is a hypothetical example:

A manufacturing company determines that the demand for its new self-propelled diesel railroad car calls for a production schedule like that in the three lefthand columns of EXHIBIT VI, after allowing time for tooling, engineering, and procurement. Its first step would be to work out a learning curve for these units, with the production schedule representing the point of departure and the size of the work force the dependent variable.

If past experience indicated a rate of learning of 80% between doubled quantities, as in the aircraft industry, it might then arrive at a learning curve something like the one shown in EXHIBIT VII. The monthly delivery schedule is indicated by the vertical lines; the points where they intersect the "curve" represent the cumulative averages of direct labor hour requirements as of the end of each month.

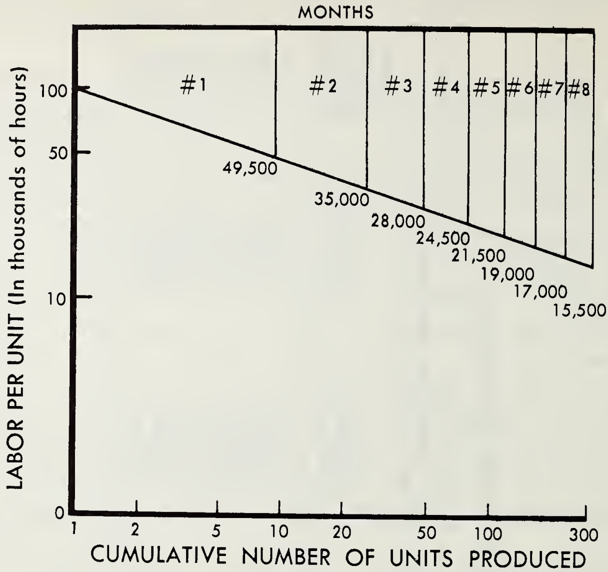
By taking these averages from EXHIBIT VII and multiplying them by the cumulative number of units produced, the cumulative total hours for *all* preceding months can be obtained (see the fourth and fifth columns, EXHIBIT VI). The differences from month to month represent the total direct labor hours for any one month (sixth column, EXHIBIT VI).

If the latter figures are divided by the number of hours worked per month (in this case 200), the needed number of direct employees can be obtained. Thus, it can be seen from EXHIBIT VI (righthand column) that about 2,228 employees are required in the first month, and about double that number in the last month, whereas the number of units produced per month increases almost nine times.

EXHIBIT VI. CALCULATION OF MANPOWER REQUIREMENTS

	Production schedule		*Manpower calculations*			
Month	*Units per month*	*Cumulative number of units*	*Cumulative averages (from Exhibit VII)*	*Cumulative total hours*	*Total hours per month*	*Total direct employees per month*
1	9	9	49,500	445,500	445,500	2,228
2	16	25	35,000	875,000	429,500	2,148
3	22	47	28,000	1,316,000	441,000	2,205
4	30	77	24,500	1,886,500	570,500	2,853
5	40	117	21,500	2,515,500	629,000	3,145
6	52	169	19,000	3,211,000	695,500	3,478
7	65	234	17,000	3,978,000	767,000	3,835
8	80	314	15,500	4,867,000	889,000	4,445

EXHIBIT VII. LEARNING CURVE ON 314 SELF-PROPELLED DIESEL RAILROAD CARS



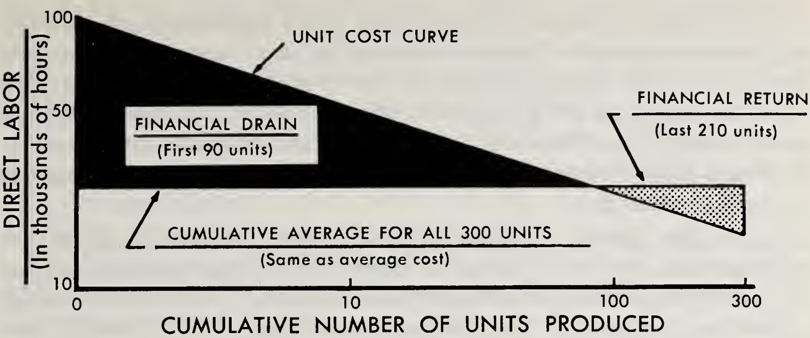
Finally, the figures on total direct employees can be broken down into the various jobs such as fabrication, subassembly, and so forth. Knowing from the master schedule when each of these types of work must start, management can estimate the necessary training time and, working backward, draw up a hiring schedule by types and quantities of workers.

IN FINANCIAL PLANNING

To the financial man responsible for raising the cash necessary to finance operations, the learning curve is a help because it affords a basis for comparing prices and costs and thus for estimating the period of financial drain when expenditures exceed receipts. Such information enables him to take any necessary steps in advance for special arrangements with customers or with the bank. One way that appropriate action can be taken in advance as a result of a learning curve forecast is illustrated by the following case (disguised):

The Emmons Company had encountered considerable trouble because its suppliers found that they lost money in the initial phases of their production. In one instance involving a contract for 300 units, the supplier found himself "in the hole" for the first 90 or 100 units since his costs exceeded the selling price. The Emmons purchasing agent recognized that this was quite natural and explained it by means of the diagram in EXHIBIT VIII. (It is assumed, for illustrative purposes, that total cost and direct labor cost are synonymous.)

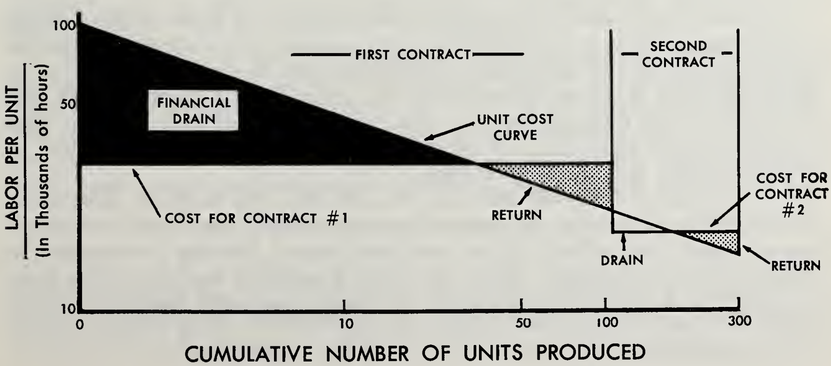
EXHIBIT VIII. LEARNING CURVE SHOWING FINANCIAL DRAIN AND RETURN



The purchasing agent suggested that, if the supplier could not sustain the drain during the production of the first 90 units, the contract be broken down into two or more contracts with successively lower unit prices based upon the successively lower average costs (see EXHIBIT IX), thus helping the supplier over the initial high costs of production.

This problem could also have been handled by one contract containing progress payments (cash payments based upon the contractor's incurrence of costs), instead of using two separate contracts. Under either method, however, Emmons would have had to use some device such as the learning curve to size up the financial implications of changing production costs.

EXHIBIT IX. THE EMMONS PURCHASING AGENT'S PROPOSAL



OTHER USES

The pricing, production, financial, and policy applications of the learning curve discussed in this section do not by any means cover the field. There are many other applications. For example, wage incentive plans could be established for groups of workers based on the steady improvement resulting from "learning"; or procurement schedules might be synchronized more closely with production needs, with resulting reductions in warehouse charges.

Rather than attempt to suggest the wide variety of specific applications in more detail, however, it might be better at this point to discuss some of the underlying criteria which individual companies could use in making a definitive appraisal of the practical possibilities of the learning curve for their own situations.

PLAN OF ACTION

There is every indication that the learning curve offers a practicable answer to the needs of thousands of manufacturing companies for fairly accurate forecasts of direct labor requirements and productivity, but it is still a new device in a more or less "experimental" stage. The forward-looking management that is interested in the learning curve today needs to know essentially two things: (1) Is it applicable to the particular situation of the company? (2) If so, what steps should be taken to construct practicable learning curves?

APPLICABILITY

Judging from what we know to date about the learning curve, its usefulness depends on these factors:

1. *Product innovation*—In companies where major and minor design changes are frequent, where new products are often introduced, or where manufacturing is characterized by short runs at well-separated intervals, "learning" is an important factor in the performance of the operators. Such companies are near the "top" of their learning curves, where savings are significant between units of production, a great deal of the time. Accordingly, accurate forecasts of direct labor time are especially helpful.

2. *Proportion of assembly time*—As we have seen, the more an operation is made up of machine time, as opposed to assembly time, the slower the reduction of labor time is likely to be, since the rate of learning is necessarily a smaller part of the picture. Thus, the aircraft industry has found that there is about a 20% or greater reduction in direct labor time between doubled quantities in the assembly of a wing, but only 10% in certain kinds of metal-boring operations.

3. *Advance planning*—The more the pressures of immediate production can be overcome so that an operation can be planned in advance, particularly in the way of methods analysis and tooling, the more *predictable* the rate of reduction in labor time will be. "Learning" in the literal sense tends to produce a smooth curve; by contrast, changes in methods, tooling, and so forth during a production run will make the learning curve "jerky" and, at the same time, probably give it a more pronounced slope.

On the basis of these criteria, industries of all sorts, in addition to aircraft, ought to be able to apply the learning curve profitably. Here are just a few possibilities:

1. *Electronics*—Here product innovation is extremely important, and the long, complicated assembly lines attest to the importance of assembly labor. The same conditions exist that have made learning curves helpful in the aircraft industry.

2. *Home appliances*—The moral of the story in the introduction to this article about the refrigerator manufacturer and the aircraft executive ought to apply with equal force to an endless variety of other products, from air conditioners to dishwasher-sink combinations.

3. *Residential home construction*—A large-scale builder of residential property should experience a decline in the unit cost of a house with successive units completed. The direct labor input on houses constructed on the site from basic materials represents, of course, a substantial percentage of the total cost. Moreover, large-scale contractors produce many basically similar units; and they use semiskilled, noncraftsman labor to a large extent, resulting in fewer union controls over output. Accordingly, they should find the learning curve useful in making up bids and forecasting the number of workers required, capital needs, and so forth.

By contrast, the learning curve would be of dubious benefit to a small contractor who builds but one or two similar units and has, therefore, very little basis for making a projection. The small contractor is often inhibited, furthermore, by union limitations on the output of skilled craftsmen.

4. *Shipbuilding*—In this industry a large percentage of the total cost is represented by direct labor. Moreover, experience in the construction of basically similar bulkheads and panels provides information on direct labor costs which can be projected to cover the units contemplated for production. Note that different sizes and variations of basically similar items can be compared for learning-curve purposes by using the relative weights of the units as a basis of comparison.

5. *Machine shops*—Even in plants where a large proportion of the work is machining rather than assembly, the learning curve promises to be helpful. Earlier in this article mention was made of a case in which a learning curve was used in negotiating the price of gun barrels manufactured by a machine company. Aircraft companies have also applied the learning curve profitably to the production of subcontractors making such products as finished castings.

On the other hand, it seems apparent that some industries would find the learning curve of little value. In the case of basic chemicals, plastics, and petroleum refining, for instance, the direct labor element is negligible; in other cases—like the manufacture of some kinds of standard toys—there is a high ratio of assembly work but very little product innovation.

CONSTRUCTION OF CURVE

If the learning curve principle looks promising to management in view of its particular circumstances, the next problem is to construct one for actual use. Here is the approach to take in doing so:

1. The first step is to obtain plottable data on number of units produced, which is fairly easy, and on direct labor hours, which may be quite difficult. Where the various hazards mentioned earlier prevail, the reduction of labor hours may be either illusory or fortuitous. Moreover, because actual direct labor hours are extremely difficult to obtain from a standard cost system, it will often be found necessary to use periodic time studies or a special job-cost system of accounting.
2. Once the necessary company data have been collected in an accurate form, they should be plotted in order to determine what the approximate slopes are for the different operations. Slopes on subassemblies are particularly desirable since they can be used in the construction of learning curves for new end products using some of the same or similar parts as products previously produced. In any event, the slope is important since starting points for the curves will usually vary from one design to the next whereas the slope or rate of learning will, judging by past experience, remain relatively constant.
3. Finally, it should be observed that the nature of the learning process is such that when the curve is plotted on log-log graph paper, it should approximate a straight line. For experience indicates that the straighter it is, the closer it is to depicting the true nature of the learning process.

PERSPECTIVE AND POTENTIAL

If one were to attempt to look back at the past and present from some future date and put the development of the learning curve in perspective, he might see it as a three-stage process in which the present is but the middle stage.

In the first stage, learning was recognized by management as a fact of industrial life, but allowances were made for it (if at all) only by hunch or by "guesstimate." No doubt some of these allowances came pretty close to the mark. In a textile mill, for example, the production manager allowed a 13-week period for learning by the work force on a certain military contract; in figuring the hiring schedule required to meet the delivery schedule, he estimated that the workers, who were on the Bedeaux system of incentive wages, would improve their production from 40 "B's" (Bedeaux performance units) per hour to 80 "B's." By astute observation he was able to approximate the forecasts that a learning curve would have given him.

In the second stage learning curves were plotted for the first time (in the aircraft industry) and specific rates of learning, usually in the neighborhood of 80% between doubled quantities, were discovered to exist for many operations. Nevertheless, valid generalizations have remained

suspect, especially about the behavior of curves in other, untried circumstances.

In the final stage, the future historian might conclude, learning curves were tested on a wide scale, refined, and many things discovered about them that were hitherto unknown. Suppose, for example, that it became possible to generalize about how much the rate of learning in operations of one type would differ from that in other types of operations; or to apply the learning curve to a variety of business operations that could not be classified as "manufacturing," but where learning was no less a factor in output.

The challenge before management today is to make this final stage a reality. From the beginning of World War II until last year there was, except for occasional brief periods, a lack of competition as businessmen used to know it. Not unnaturally, executives became less cost-conscious. There was no great urgency about spending the time and money that would be necessary to develop practicable learning curves such as those used in the aircraft industry. But now, with hard competition back, there is every incentive to collect the data, plot the curve, test it, refine it. The aggressive, forward-looking management will not wait long. The learning curve is a device that promises to have many important uses.

IX

MARKETING OPERATIONS AND THE ADMINISTRATOR

34. THE TRUE ROLE OF THE MARKETING EXECUTIVE

T. V. Houser*

This article is based on a Charles Coolidge Parlin Memorial Lecture given under the auspices of the Philadelphia Chapter of the American Marketing Association on May 27, 1958. Mr. Houser states that the marketing executive's knowledge of the market and methods must play a major part in areas of the business which traditionally have not been considered a part of his responsibility, and that this will result in increased business effectiveness.

TWO PATTERNS OF DISTRIBUTION

Two patterns of distribution have emerged in the United States. The traditional pattern is that of the large manufacturer whose products are distributed by great numbers of small dealers. There may be independent or producer-controlled wholesaler activities included in this system. However, it is typified by a combination of large producer and small distribu-

* From the *Journal of Marketing*, XXIII, 4 (April, 1959), 363-69. Reprinted by permission of the author and the *Journal of Marketing, national quarterly publication of the American Marketing Association.*

tors, with the manufacturer exercising marketing leadership through a variety of methods, chiefly advertising, to presell the product and secure distribution.

In competition with this system of large producer and small distributor is that of the large distributor furnishing an outlet for the products of a great number of small manufacturers. In this case, product determination is the responsibility of the distributor; and marketing leadership also comes from the distributor through product advertising, display, direct-sales effort to the consumer, and customer-credit arrangements.

Neither of these patterns is static. For example, major producers of durable goods have been reaching forward to the distributor function . . . in an effort to integrate the selling and production effort, and to get the benefits of increased volume and lower costs.

THE MARKETING FUNCTION

The chief executive officer of a business must keep a sense of balance between the various functions comprising his organization. He must also determine which functional viewpoint will have the greatest influence on over-all decisions. Some executive officers give great weight to the accounting-and-control function. In other companies where the emphasis is placed on technical areas, the engineering executive and the production executive are considered the most important.

The view here is that the *marketing function* is the one to carry the most weight.

Selling effort starts with the determination of the product. Therefore, the marketing function must have a strong voice in research, development, and production decisions.

So long as the customer is free to buy from competing sellers and producers, the function of the business closest to the customer must carry weight in influencing the decisions that determine the character and cost of the product. Necessarily, this requires marketing executives who are sales minded, thoroughly grounded in business economics, sensitive to both the possibilities and limitations of mass-production techniques, and profit conscious.

RESEARCH, DEVELOPMENT, AND PRODUCTION

RESEARCH

Most firms carry on some form of applied research independent of current production engineering activity. This may involve prospective improvements in quality, utility, or costs of current products, or may be directed toward new products.

The chief executive officer must decide on the scope of this effort in relation to the business as a whole; but the *marketing executive* should have a major voice in the objectives toward which this activity is directed. Salesmanship of a product really starts at this point. Very often the production cost of a desirable feature added to an existing product is a more effective expenditure of money than the more conventional avenues of sales expense. Yet a proper balance between various elements of unit costs must be maintained. The marketing executive should help to set cost limitations on product-research objectives, so that impractical work will not be undertaken.

In like manner, research work on new products must face the marketing test. All too often the engineering and design department and the production department have ideas as to new products which will fit into the type of equipment, skills, and techniques of the work force, but which cannot be distributed through the existing marketing channels. Full consideration must be given to what is involved in creating appropriate channels of distribution for such new products. The marketing executive is the one to spell this out.

Product research usually involves improvement in quality or utility; this may mean greater aesthetic satisfactions in use, greater conveniences in use, or longer life. Here again the marketing executive should establish the priority and relative values, because cost limitations ordinarily will not permit the adoption of all desirable improvements. Here he must reflect a correct interpretation of the desires of that part of the general market he is serving, in order to strike the balance of features and price that will expand the market.

DEVELOPMENT

Consider also the competitive conditions which a business faces. A marketing executive must determine the number of different items which will constitute his firm's line of products, be they electric irons, men's shoes, or television sets. As a rule, his sales force wants to have a product to match every individual offering of all competing manufacturers. On the other hand, the engineers and production men know that the smaller the range of items, the lower the unit costs will be because of less tooling expense and longer production runs. The marketing executive must stand between these two pressures, sensitive to each, and make appropriate judgments.

Any merchandise line usually consists of a beginning number with minimum quality standards, minimum features, and primary emphasis on price appeal . . . a medium number designed to appeal to the largest market, with recognizable, justifiable, and demonstrable differences of quality and features . . . and a "top-of-the-line" number with qualities appealing to the higher-income market.

The marketing executive must know when to add a number, when to drop one, and when to substitute a new one for one to be dropped. The "image" which the public forms of a given line of products is largely in his hands, not because he originates the ideas expressed in merchandise, but because he has a grasp of the economics involved and a feel for the public's attitudes and preferences.

PRODUCTION

The next step is the specific product, determination of design, and the organization of the sequence of production operations. At this stage it becomes necessary for estimates of specific quantities to be made for each item in the proposed line. Only the marketing function can have the experience and general feel of the market necessary to develop dependable estimates. The degree of tooling must be determined, involving the balancing of the additional amortization which complete tooling requires against the added labor costs where less tooling is possible.

While the engineering designs and the production plans are being made, aesthetic design is also under way. Here again is an area where judgment and balance from a marketing viewpoint are essential. All too often customer convenience and utility are sacrificed to a standard of pure aesthetic design which exists in the artist's mind.

Choices of various materials are often possible, as well as various processing methods; and the marketing viewpoint must carry weight wherever decisions on these points might involve consumer preferences. More than this, problems of economical shipment, breakage, mechanical failure, or rapid deterioration must be taken into account.

SALES MANAGEMENT

About this time budgets begin to take shape, based on sales prospects, manufacturing schedules, and projections of various elements of expense and investment. This is the area of direct sales management, which includes the management and control of the sales organization, advertising, display, and all sales activities.

TWO POINTS

In this connection, two points should be made.

The first is the importance of co-ordination of advertising, sales effort, service of supply, and all the other devices used in modern selling. If these parts are not properly fitted together, a great deal of the research time and production effort can be dissipated by a faulty sales campaign.

The second point deals with the management of the sales organization. This calls for the very best kind of personnel administration. It involves not only selection, training, and incentives, but also relationship to management. Sound personnel policies are important in every part of any business, but are *vital* to the sales organization.

COSTS IN DISTRIBUTION

The marketing executive should realize that the intrinsic quality of an article of merchandise is determined by its design, the kind of materials used in its manufacture, and the degree of precision and competence in its manufacture. When it reaches the end of the assembly line, packed for shipment, its level of quality is forever established. It may still go through a number of shipments and trans-shipments, be unloaded, and held in storage a number of times; title of ownership may be transferred several times; and it will be handled in different places by different people before it reaches its destination in a customer's home. As a rule a relatively small part of its ultimate cost to the consumer was expended for material, labor, factory overhead, engineering, and tooling costs. For a common run of items, this proportion would range around 40 to 50 per cent.

But the expenses incurred beyond the assembly line, although not adding to the intrinsic quality of the article, have added greatly to its cost. The technology of mass production is so well developed that one can hardly expect significant contributions to improved living standards, or the creation of broader markets through cost reductions.

From a mathematical standpoint, value could be defined as equal to quality divided by price. Double the quality without change of price, and you double the value; double the price without change of quality, and you have one-half the former value. Since quality is determined on the manufacturer's assembly line and has not changed at the retail level, the value of the product to the consumer is reduced by successive distribution costs. Since it is at the retail level that the manufacturer's product must gain preference of retail customers, any shortcuts or efficiencies introduced along the line will increase the value of the product in comparison with competition.

Realizing that layer upon layer of distributive costs does not add to the worth of his product, the marketing executive turns his attention to ways and means of reducing this spread between direct production costs of goods and the price the consumer pays. Two functions of distribution are so basic that they cannot be avoided.

The first is the wholesaling or distributor function, which may be carried out by the manufacturer either at the factory or a number of regional points of distribution; or by independent operators of regional distribution points; or by a large-scale retailer or operator of multiple stores.

The other function is the point of contact with the ultimate consumer, usually through retail stores (with mail-order a unique exception). Efforts to bypass these elementary functions through direct-to-consumer selling have been limited and successful only with larger margins than permitted by conventional channels.

STABLE PRODUCTION

One of the great savings in the cost of producing goods, particularly of a seasonal character, is to maintain a stable level of production day in and day out. In two plants with comparable individual costs, one plant may have markedly higher total costs at the end of a year, even if both have adequate volume. Analysis will generally show, in the plant with the lower costs, that every machine runs all or most of the year, with individual runs of a given part sufficient to justify the cost of machine adjustments to make that part. Year-end cost savings of 10 to 15 per cent are obtainable, when a highly seasonal article is produced steadily throughout the year. This means proper marketing planning.

The full benefits of this type of production can best be realized when there is assurance that the retail outlets will carry the line produced. Uncertainty as to stocking the line tends to be removed if firm contracts can be established with large retail chains.

PACKAGING

Sometimes marketing executives overlook the importance of having correct and adequate information "tags" on articles. The differences between various qualities must be made clear to the prospective buyer; this is also a means of educating the salesperson on the job. Many times the selling effort by the manufacturer has gone on the outside of a container, which is thrown away when the article is placed in retail display!

An example of the power of packaging involves rosebushes. Here is an item, pruned root and branch, which may not suggest to the customer its ultimate beauty. However, with proper packaging to illustrate its appearance in bloom, a rosebush becomes an item with great appeal, and produces the plus sales that come from impulse buying by the customer.

STOCKKEEPING

Store display and arrangement are important, and very often proper help from the manufacturer is important. However, such help must be compatible with the general appearance and character of the store, practical in taking care of customers on a busy day.

Probably the greatest single opportunity for improvement in the whole field of distribution lies in stockkeeping. The marketing executive must

see the whole sequence from the original design to the product in the home, and maintain a steady, consistent flow of goods through the entire stream. He must realize that a salesman who sells his product to a retailer by inducing that retailer to carry a wider range of selection than his business will support is really doing the manufacturer a great disservice.

So far as possible, each retailer should be counseled as to just what range of products would be most suitable, taking into account sales volume and floor-space, so that the store is always in stock and not worried about over-stocks.

ADVERTISING

A perennial problem is the evaluation of advertising. The objective to be accomplished by a given advertisement should be kept clearly in mind. For instance, some programs are aimed at preselling the consumer; others are psychological weapons in the competitive war, and are intended more to convince a retailer that the public is already presold; while still others have the more intangible justification of building prestige.

Some manufacturers of cereal, soap, and similar products set up a unit advertising amount in the cost projection of a product and then keep an advertising variance account, just as is done in the shop for material, labor, or overhead standard costs and variances. Wherever this technique is applicable, it sharpens the marketing executive's analysis and appraisal of the advertising dollar.

DECENTRALIZATION OF INDUSTRY

The decentralization of industry is another matter which requires the attention of the marketing executive.

Decentralization can be the key to developing a balanced economy regionally, maintaining more even population growth, and contributing to a more stable economy and better standard of living. It is an almost ideal situation when an area develops a reasonable balance between agriculture and processing industries. If an area can add raw material for those industries, then it becomes that much stronger, with even greater basic importance to the economy as a whole.

So far as marketing is concerned, there is a vast difference between selling the products of a distant producer in a given region as against those of a local manufacturer. Even if a distributing warehouse is used, the local plant still has great advantages. There is something to be said for being an integral part of a community. There is the good will which comes from participation in local and regional public service . . . the value of close

contact between the sales personnel and plant executives . . . greater attention to service of supply and to mechanical service matters . . . greater concentration regionally of selling techniques, including advertising.

This does not imply that the marketing executive must be the dominant voice in decisions concerning a distant branch plant. But, if a company faces the problem of expansion, he should analyze the opportunities for increased volume resulting from a regional plant and develop the basic economics of such an operation. Usually raw materials are available in part in most regions; but, if they are not, the saving in shipping finished goods from the heart of a region greatly offsets the costs of shipping raw materials to the plant. Unless the marketing executive has the imagination and strength of conviction to present fully the branch proposal, the production executive will probably see to it that merely a new wing is added to the present plant.

CONSUMER CREDIT

Next, consider the growing importance of consumer credit. This development has brought a train of problems in its wake; but our great mass-production industries could not be supported without credit selling.

Installment-credit selling in some form is here to stay, although no one knows exactly what level it will attain in our national economy. Increasingly, credit is an important point to take into account in selecting dealers and distributors. Where sound financing is not available to otherwise acceptable dealers, the manufacturer can probably organize such financing services or help arrange for them.

OUR DYNAMIC ECONOMY

Ours is a dynamic economy, constantly undergoing rapid changes, and these changes can have immediate or long-range effects on marketing plans. For example, what weight should be given to the fact that, for every person added to the potential labor force since 1940, two were added to the group to be supported by the labor force?

What should be the influence on marketing of the growing numbers of our population in the lower-age groups?

What is the marketing impact of the growth of the suburbs?

What are the implications for advertising and sales of the movement of our population to states in the West and the Southwest, and the population growth of other states adjacent to the population centers of the Atlantic seaboard?

What is the significance to the marketing function of an increase since 1950 of 35 per cent in the highly skilled professional and technical group in industry, and a decrease in the number of unskilled workers?

Should an increase of 32 per cent since 1946 in the number of women in the work force be a factor in making marketing plans and projections?

What is the significance of the tremendous gain in productivity on the farm, with one farm worker now producing the food requirements of twenty people in 1957, as against less than ten in 1940?

What bearing does increased leisure time have on marketing decisions?

Public and private insurance plans covering hospital, surgical, and medical care, health-and-accident insurance, life insurance, and pension funds have assets totaling an estimated $72½ billion, and are increasing at the rate of almost $5 billion per year. What is the importance of this deferred income to long-range sales planning?

Forces such as these exert a steady pressure for an infinite variety of goods. Knowledge of these forces, their directions, and their intensity—with an understanding of their effect on business—give the marketing executive his greatest value.

35. PLANNED MARKETING: KEY TO INCREASED PROFITS

Charles W. Smith*

Marketing as a separate management function, not to be identified solely with selling and advertising, is regarded by the author as a necessary and important step toward improving profits in the future. A marketing department so conceived will be integrated with those of other company departments.

CONCEPT OF THE MARKETING DEPARTMENT

As a phenomenon of industrial organization, the marketing department is a relatively recent development. Fundamentally, it is an outgrowth of more than twenty years of discussion about the need to increase distribution efficiency. Of all the subjects that might have been selected, I can think of no other that would be more timely or important to any group of thinking executives. Planned marketing, based on recognition of the "total marketing" concept, is gaining increasing recognition in top man-

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* From *Planned Marketing—Management's Responsibility*, Marketing for Executive Series, No. 4 (1957). Reprinted by permission of *Planned Marketing—Management's Responsibility* and the *American Marketing Association.*

agement circles as one of the principal approaches to improving a company's profits.

Reduced to the simplest possible terms, the marketing department of any industrial company is simply an organization device for giving formal recognition to the concept that marketing is a separate, and very important, management function. Despite its simplicity, this concept has proven in many cases to be a difficult one to build into an existing corporate structure. For whenever any new concept develops in the field of scientific management, some companies seem to mistake the form for the substance of what is basically a sound idea.

A well-planned marketing operation cannot be achieved simply by creating a marketing department on paper. Major companies that have endeavored to establish a really effective marketing department have learned that the task involves much more than merely assigning some executive a new title and drawing up a new organization chart.

For a marketing department to become an effective part of an enterprise, its activities must be integrated with those of every other company department. Those responsible for administering its operations must clearly visualize the role of the marketing function as separate and distinct from either selling or advertising, while continuing to recognize the vital importance of both these functions in the total marketing operation. Top company executives must also adjust their patterns of decision making to reflect the concept that all sound corporate planning is based on a predetermination of the markets to be served.

In many companies where the "total marketing" philosophy has not as yet gained acceptance, forward plans are still being founded almost entirely on engineering, production, or financial considerations. As long as conditions make it possible for such companies to operate profitably, there is no pressure on them to move in the direction of establishing marketing departments. Three basic factors in our economy, however, are tending to make it increasingly difficult for any company to achieve optimum profit results without giving primary consideration to marketing factors in developing its long-range plans.

RAPIDITY OF CHANGE IN TODAY'S ECONOMY

The first of these factors is the rapidity of change in the economy. Markets that once were stable, and continuing, can no longer be taken for granted; change has come to be the distinguishing characteristic of our age.

In such a world of constant and dramatic change, it is becoming more and more profitable to conduct the research required to find out everything that can be predetermined about a potential market before attempting to serve it. We can no longer take it for granted that we will always

be able to sell a good product if we can make it. Total capacity to produce is now so great that demand for a product must be created continuously to insure profitable employment of productive facilities.

First, we must be sure that products are designed to fit the needs of the market as well or better than competing lines. We must also make sure we have created an awareness of those needs, of sufficient intensity, to bring potential consumers into the market to buy.

When marketing research tells us that there is no ready demand for a product, whether it is new or established, we must then determine what sales appeals can be used to create demand and locate potential customers who will respond to such appeals. Only then do we have a sound basis for a long-range promotion program that will support a planned level of output.

Companies that have not taken these basic marketing planning steps, or have miscalculated their market planning, have often found themselves saddled with beautiful plants that could not be operated profitably. Financial retrenchment then becomes the order of the day, and as competitive conditions become more severe, companies that have failed to do effective marketing planning are among the first to fall.

Another aspect of our changing world is the constant shifting of consumer preferences from one product to another. This is most marked in the so-called "style industries," which have long recognized the need for keeping their fingers constantly on the pulse of market demand. This factor of change, however, is rapidly becoming more important in other traditionally more stable industries.

These market changes do not occur overnight. They can be foreseen by the alert observer, sensitive to the importance of new developments. Yet many companies have gone blindly ahead making products in declining demand until their profit positions have been completely eroded. Other companies, more alert to market developments, have seized opportunities to shift investment into profitable new fields, and rapidly changing market conditions have given strong impetus to the development of marketing departments.

INCREASING COMPLEXITY OF DISTRIBUTION

The second major factor in the growing importance of the marketing function is the increasing complexity of distribution. For the past twenty-five years the primary attention of top management, in a large majority of companies, has been concentrated on the critical problems involved in raising production efficiency; distribution efficiency has been very largely taken for granted.

One amazing aspect of our industrial economy is the level of enthusiasm exhibited by top-management executives for fundamental research in the field of engineering. Company after company has poured hundreds of

thousands of dollars into the construction of new scientific research laboratories that are now producing a constant stream of new product ideas. Relatively few companies, however, have as yet conducted either the kinds or the total amount of distribution research required to evaluate the product ideas developed by their engineering research. Better co-ordination of marketing research and product research efforts is thus becoming a major problem of top management. Thousands of dollars have been wasted in developing products that no one has been able to figure out how to market profitably. At the same time, many opportunities for profitable application of new product ideas have been overlooked for lack of sound distribution research.

In some industries, such as the home appliance field, distribution has become the primary factor determining a company's competitive position. The trend towards production of a complete line of appliances by major manufacturers has made it increasingly difficult for producers of partial lines to secure top-flight wholesale outlets and has contributed to the recent wave of mergers between partial line manufacturers seeking to maintain their competitive positions in the field.

More and more products and product lines are being designed and developed in terms of the competitive conditions imposed by the channels of distribution through which they must flow. Pricing and promotion policies are also being adjusted to reflect trade practices of distribution outlets over which the manufacturer has only limited control.

Distribution systems that once consisted of only one basic channel have now been expanded to cover several channels. In the surgical dressings industry, for instance, the traditional pattern of distribution through drug wholesalers has been amplified by direct sales to variety store and supermarket chain warehouses. Changes in the distribution systems used by manufacturers have come about as a result of three developments: (a) efforts of established retail outlets to broaden the base of their operations by the addition of new product lines, i.e., the creation of drug sundry departments in food stores; (b) growth of new types of outlets, i.e., supermarkets and discount houses; and (c) efforts of manufacturers to broaden the base of their operations by the addition of new product lines, i.e., the entry of plumbing-heating supply manufacturers into the kitchen cabinet and appliance field.

As a result of these changes, problems involved in planning and controlling inventories held in the distribution pipeline have also become increasingly complex. Product lines are longer and customer service requirements are more demanding. Warehousing space and labor costs and working capital tied up in obsolete or slow-moving inventories are all rising rapidly where distribution costs have not been under tight control. Analysis of situations in which distribution costs were found to be out of line has disclosed inefficiencies that are often the result of a poorly designed distribution system.

Any company which subjects its distribution operations to searching analysis will usually find many opportunities for profit improvement such as: warehouses poorly located from the standpoint of fast, economical service; archaic order-handling systems; greater use of modern materials handling equipment and improved methods of inventory control; profitable orders lost to competition through inability to give prompt reliable service, or lack of sufficient sales contacts.

The increasing complexity of distribution systems has placed a premium on sound planning and control of distribution operations. Typical functions that can be assigned to marketing departments include: setting standards of performance for every important distribution function; evaluating methods and procedures to determine ways of increasing efficiency; and designing and locating facilities with a view to long-term growth potential.

NEED FOR BETTER SALES FORECASTS

The third major factor that has given impetus to the creation of marketing departments is the increasing importance of sales forecasts as the basis for all corporate profit planning operations. Capital investment requirements of corporate enterprise are now so great that top-management executives must have sound marketing plans on which to base judgments regarding the potential profitability of future operations. This is particularly true of industries in which automation has become an important factor determining a company's cost and profit position.

Many companies are now projecting their operations as far as ten to twenty years into the future. No one can forecast in any detail what will take place so far in the future, but decisions made today regarding the scale and location of plants and warehouses actually set effective limits on a company's competitive position and profit structure for many years. Technological developments are coming so fast that only the most astute management executives can keep them in proper perspective. The more information a company has about long-term growth patterns the better its capital investment plans will be.

FORMAL NATURE OF THE MARKETING PLANNING FUNCTION

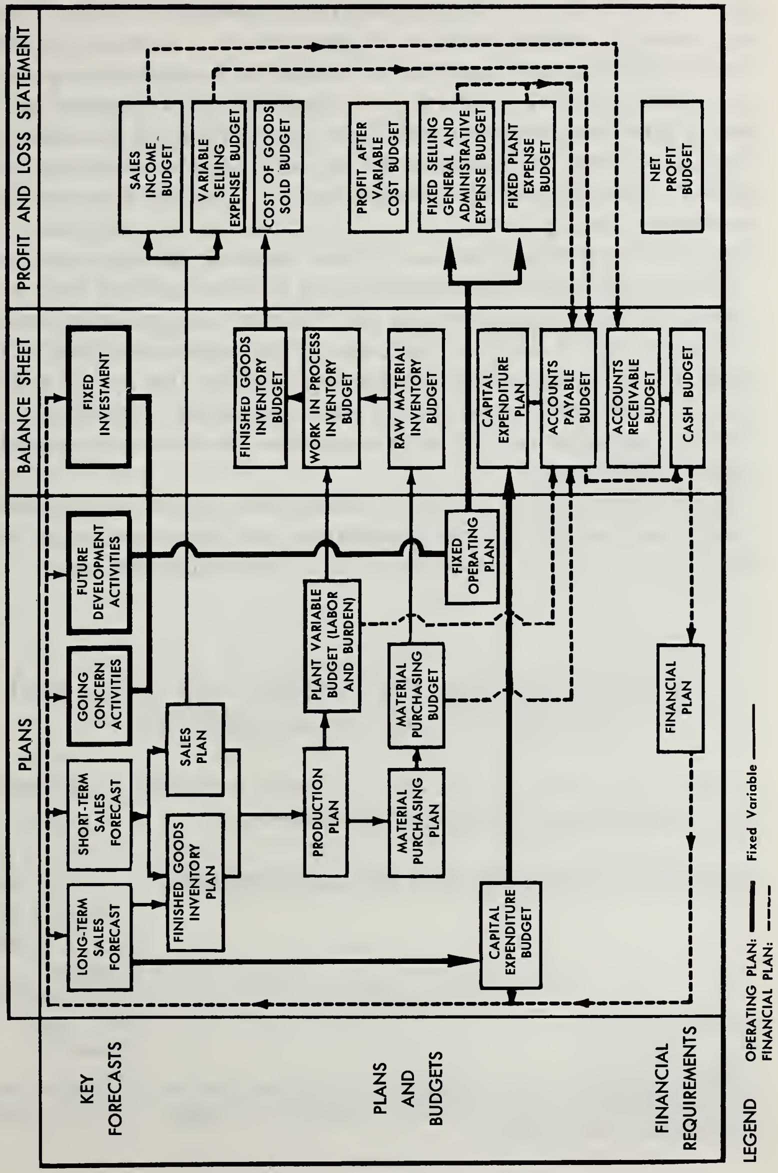
The vital role of marketing planning can perhaps best be appreciated in terms of the profit planning cycle of a make-and-sell enterprise shown in Chart 1. The cycle starts with the long- and short-term sales forecasts and the sales plan. It is the responsibility of marketing departments to prepare the sales forecasts and sales-plan figures which in turn provide the basis for all subsequent steps in the profit planning cycle.

The kind of marketing planning described is formal in nature and the need for such formal planning seems to depend on the size and complexity of the individual enterprise.

CHART I.

THE BASIC STRUCTURE OF PROFIT PLANNING IN A MAKE AND SELL COMPANY

(Prepared on Direct Costing Basis)



All companies—even the smallest—carry on informal planning activities which are simply taken for granted. The need for more formal planning methods is usually not recognized until operations reach a certain stage of complexity. At that point, informal plans no longer provide a sound basis for administration of the enterprise.

The concept of integrated formal planning of a company's operations grew out of the work of the managerial accountants who developed the basic concept that the manager of any phase of a company's operations should be held accountable for the results he has achieved against predetermined objective standards of accomplishment. Budgeting and forecasting grew out of this concept. The cycle of planning illustrated in the diagram indicates the ultimate development of this accounting idea as applied under the method of direct costing. Thus it is apparent that the marketing planning functions is a by-product, or an outgrowth, of the long-term trend toward the use of more scientific management methods.

The growth of the marketing planning function has been slow in some companies because top executives have failed to recognize that it requires a different type of skill than that required for success in selling or advertising. The experience of most companies has been that formal marketing plans were not well prepared until this responsibility was clearly recognized as a separate and distinct management function and assigned to a marketing department.

Planned marketing is a key that management can use to open the door to increased profits; for this reason more and more companies will be establishing marketing departments in the years immediately ahead.

36. EXECUTIVES TELL HOW TO USE COST ACCOUNTING IN MARKETING*

Five top executives tell how cost accounting is or can be used in marketing—its limitations, advantages, and prospects.

"ESSENTIAL BUT NOT THE WHOLE ANSWER"

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* From *Industrial Marketing,* XLII, 12 (1957), 102, 104, 106. Copyright 1957 by *Advertising Publications, Inc.,* 200 East Illinois Street, Chicago 11, Illinois. Reprinted by permission of the publisher.

Cost accounting, properly interpreted, is essential to management for guidance in avoiding unprofitable sales and seeking to make sales which produce optimum profits. But cost accounting itself cannot be the whole answer.

Management must also take into account such marketing and production considerations as the relationship of the unprofitable product to the more profitable ones, the advantages of carrying a "full line," the stage of market development of a particular product or line, the effect of volume on costs, the maintenance of a stable work force and the most effective employment of production equipment.

Not every sale can be expected to result in maximum profits. A reliable business must stand ready to meet its customers' needs, and in so doing it must be prepared to make deliveries of some products that are less profitable than others.

But the more we know about our over-all cost picture and the better data we have on the real costs of producing and selling each product in each marketing area, the better we are able to aim our market development in the direction of better profitability.

No cost figures are really "exact," and this is inclined to be particularly true of marketing costs. Nevertheless, it should be possible for most companies to allocate on a reasonable basis their over-all marketing costs to individual products, territories and even customers. The extent to which it is practical and desirable to do so may depend, however, upon the cost of obtaining the necessary data and the value placed upon the breakdowns when they are obtained.

New data processing systems and equipment are being brought into operation to enable management to do a better job of collecting and analyzing the information needed for correct and more precise allocation of costs. Such machines and systems will not supplant sound business judgment, but by proper coding and tabulation, make the information more useful in arriving at accurate cost breakdowns, correct judgments and sound marketing policies.

In these days of rising costs and keen competition, management cannot afford *not* to take advantage of every modern tool and technique that it can bring to bear on the problems of accurate cost accounting and sound market analysis.

"SALES VS. BUDGET" POINTS WAY TO PROFITS

By C. S. Hallauer
President
Bausch & Lomb
Optical Co.
Rochester, N. Y.

Competent and comprehensive budgeting in every phase of our operations has always seemed to us to be an indispensable part of modern management and operating control.

Our controller's division works closely with our different sales departments in setting up our annual budget. It also helps in periodical reappraisals. It provides a constant flow of information on sales vs. budget. It shows us—in monthly reports—which lines are affording a satisfactory profit and which lines are unsatisfactory.

With this information, the sales and advertising departments can emphasize those products which offer the best profit potential. Their ability to do so has a direct relationship to our operational profit, even though it is not always practical to discontinue or to completely de-emphasize unprofitable lines.

The information provided by our controller's division is comprehensive in character and adequately covers the primary needs of management and our sales divisions. We know our marketing costs on every one of our many sales classifications. We have a complete geographical breakdown for selling expense of our regional sales divisions. We know specifically the cost of operations in every one of more than 150 branches and the degree to which each contributes to our over-all accomplishment in terms of both sales and profits.

This sort of information serves to spotlight areas of strength and of weakness. We have found it most valuable in the formulation of future plans.

DOES COST DATA COST TOO MUCH?

By R. A. Pritzker
President
Great American Industries
Elyria, O.

Cost analysis of the sales function for a company is essential to good management. This axiom is, however, not the whole story. The real problem, which requires management thinking, is the economic feasibility of obtaining such costs.

Several years ago while engaged in consulting work, I had occasion to show a midwestern manufacturer that for a number of years his marketing cost in the New York area actually exceeded his gross sales. Although this is a striking and obvious example, the executive involved has been tremendously successful in sales. In a medium or large corporation where

the sale of many products is involved, it is almost common to find unprofitable sales efforts that could be eliminated with proper cost analysis.

With modern electronic tabulating equipment, it is possible to produce almost any conceivable breakdown of sales expense. Most companies must, however, carefully determine what information is necessary and can be the catalyst for corrective action. It is difficult to generalize on the amount of breakdown that is feasible because of the variation in product from company to company. For example, a firm whose average invoice is less than $2 would find marketing statistics or marketing cost analysis far more expensive than would a business whose average invoice is $1,000.

The Colson Corp. (a subsidiary of Great American Industries) has found invaluable its analysis of marketing expenses. In certain areas the company uses distributors, while in others, direct salesmen are employed. This gives rise to the question of which method is more economical and which produces the most sales. Although there are many opinions expressed on this question, we have found by a careful analysis that is is a complex question and must be handled differently in each marketing area.

It is apparent, then, that generalization is impossible regarding the usefulness of cost breakdowns. It is necessary to first make an economic study comparing the expense of a cost breakdown to the probable increased profits resulting from such a program. Most companies find, I think, that certain cost analyses give great returns, while other breakdowns are far more expensive than the profits received.

FINDS PITFALLS IN "OFF LIMITS" AREAS

By R. B. Seymour
President
Loven Chemical
of California
Newhall, Cal.

Like other management tools, cost accounting must be used for the control of all phases of marketing programs. The principal pitfalls are usually in research and development which are sometimes considered "off limits." Yet, cost accounting must be applied at least as rigorously here as in advertising and sales promotion. Otherwise, results will be unrealistic and of questionable value.

In every well-managed sales organization, marketing costs can be determined on the basis of product line, territories and customers. The preciseness of the data depends on factors which are not always under control. Nevertheless, a realistic breakdown usually provides surprisingly good and sometimes embarrassing answers.

Certainly the data can be sufficiently quantitative to permit management to be objective and make decisions essential for progress. It must be emphasized, however, that judgment and intelligent interpretation are at least equal in importance to the exactness of these data.

CITES DRAWBACK OF "UNFEELING FIGURES"

By F. H. Orbison
President
Appleton Woolen Mills
Appleton, Wisconsin

Is cost accounting the answer to avoiding unprofitable sales, if used for all aspects of a company's marketing program—research, product development, advertising, sales management and sales promotion?

There is no such thing as "the answer."

The question you have asked is: "How can cost accounting best be used in managing sales?" There appear to be two possibilities.

1. For the control of both direct and indirect selling costs. This is very difficult since arbitrary judgments are involved in establishing the basis for allocations.

2. For measuring the effectiveness of allied programs such as research, product development, advertising, sales promotion and sales management. This seems quite worth while.

The determination of values is a responsibility of good management. In this determination, cost accounting can be a helpful tool, but figures don't have feelings. The evaluation of people is more important than the evaluation of figures. People produce the figures and they are measured by them.

In avoiding unprofitable sales, we don't look to cost accounting as being the answer. It is a means to reaching an answer but not the end.

Do you believe it is possible for the average company to break down its marketing costs, exactly, by any or all of the following classifications: individual products, territories, customers?

We do not believe it is possible for any company to break down its marketing costs "exactly" by individual products, territories or by customers.

This is because cost accounting of some sales costs can only be based on arbitrary allocations. For example:

1. How can you break down travel expenses by products or by customers? This is done best by territories, assuming you have a single method of distribution for all your products.

2. How can the cost of samples be broken down by customers? We can do this by products—perhaps even by territories.

3. How can entertainment costs be broken down by products? We can do it by customers and perhaps by territories but not by all three.

There are probably other variations for other companies. It is important to remember that each company is different from the average.

For us, a breakdown of costs by territories is the best basis for allocation. But even so, there are some costs which are not readily allocable by territory—research, product development, advertising, and to some extent sales promotion and sales management.

To try to allocate these costs by territory would produce unreliable or misleading figures. Marketing decisions based on figures alone would be ill-advised.

X

PERSONNEL CONTROL AND THE ADMINISTRATOR

37. AN IMPORTANT MANAGEMENT HELP: A PLANNED PROGRAM FOR PERSONNEL QUALITY CONTROL

Thomas J. Wright*

The author tells how a personnel quality control program can be set up, what it should cover, how to make it function, what departments within a company should handle various parts, and briefly explains how such an over-all program can be effectively operated.

The control of quality is a most important factor in the manufacture of material products; so is quality control important with respect to the human beings who are engaged in the various activities involved in the manufacturing process and in the related processes of design, inspection, sales, and so forth. The effectiveness of the techniques developed for controlling the quality of the products can be minimized or increased to a considerable extent depending upon the program which has been developed for personnel quality control.

The objective of this article, is to indicate how a program for personnel quality control functions, and how the techniques developed for the

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control of product quality may be applied to the personnel field. The steps to be covered involve the following items: job specification, screening techniques, induction to company, training on the job, job performance review, and organization to accomplish the foregoing.

The examples and forms included in this paper are drawn for the most part from a large and progressive carpet manufacturing company. This company, employing some 10,000 production and maintenance, technical, sales, clerical and sales personnel has made considerable progress during recent years in the development and application of personnel quality control.

The job specification serves the same purpose with respect to the control of the quality of personnel that the material specification serves insofar as material quality control is concerned. That is, it specifies the duties to be performed under specified working conditions by the incumbent of a specific job along with the related responsibilities and lists the characteristics such as previous formal education, specialized skills, on-the-job training, job test scores, and so forth, which the incumbent must measure up to in order to perform the job satisfactorily.

The personnel requisition serves the same purpose with respect to the recruiting of the proper personnel for a job that the purchase order serves when material supplies are involved. Often a copy of the job specification is attached or, if not, a digest of the information contained thereon is used. In addition, the number of persons required, the date required, location of work, and starting rate are included plus provision for the necessary approvals which must be obtained before recruiting starts. Copies of the personnel requisition usually are sent to the payroll, personnel and requisitioning departments after the selection has been made.

Just as all material shipped into a well-managed plant is inspected before being accepted, so must new personnel be subjected to a similar procedure. This personnel acceptance inspection usually consists of the following parts: interview, tests, medical examination and references.

SCREENING, INTERVIEWING AND OTHER TESTING TECHNIQUES

The job applicant usually is requested to fill out an application for employment, thereby furnishing information regarding formal education, special training, work experience, age, marital status, etc., on the basis of which the initial screening may be made to determine whether he meets the job specification requirements sufficiently to warrant an interview. If the job is of a technical or artistic nature, the applicant is often required to furnish samples of his work when filing his application. This is similar to the manufacturer who is required to furnish samples of his product when he is trying to obtain an order either for the first time or for a large quantity from a purchaser.

If a review of the application by the interviewer indicates that the applicant apparently possesses the necessary job qualifications, he is given an interview, during which any required personnel tests are given. During the interview an attempt is made to analyze the applicant's personal traits, appearance, ambitions, etc., to determine whether he will "fit" into the company's working organization, assuming that he has the other necessary qualifications.

In addition to the pre-employment tests the applicant is usually required to serve a probationary period of from one week to several months, depending on the nature of the job, during which time he works under close observation to determine whether he can perform the required duties.

In order to check on the accuracy of the job applicant's statements regarding his previous education and experience, reference letters are sent by the employer to the applicant's previous employers and heads of schools which he attended. The replies to these letters, particularly from the previous employers, often contain little other than recorded information regarding length of employment and job classification. Of course, if the applicant's record was a very good one and his former employer is desirous of helping him make a change, the reply may contain favorable comments.

An important step in the control of the quality of personnel which most of the larger employers are utilizing is the pre-employment and periodic medical examination. The former is usually given at the conclusion of the employment interview and personnel testing procedure.

PHYSICALLY HANDICAPPED OFTEN DO BETTER JOB

While there are a number of diseases which immediately disqualify a person for employment, this is not true with respect to physical handicaps such as the loss of a leg, an eye, defective hearing, etc. There are many jobs on which a handicapped person can often perform better than one who has all of his faculties. It is the duty of the medical department to fit the person to the job from a physical standpoint while at the same time using discretion in providing for future replacements in the better jobs by selecting a high percentage of fully-qualified (physically) employees.

The practice of giving periodic physical examinations to detect any incipient diseases is becoming more popular, particularly in companies which are large enough to support a full-time medical staff with modern diagnostic equipment.

It has been found from experience that the quality of a company's personnel is improved if, before the new employee is actually assigned to a specific job, he is given an opportunity of orienting himself by learning

something about the company's general personnel and other policies, its products, organization and manufacturing and distributing facilities. This indoctrination is usually a responsibility of the personnel department's training division and is accomplished by the distribution of pamphlets and handbooks, talks by selected management personnel and visits to company plants and showrooms whenever feasible.

The induction program, in addition to giving the new employee a bird's-eye view of the company of which he is becoming a part also provides an opportunity of providing him with first-hand information and answers to questions instead of waiting until he is faced with a situation requiring an answer which may be given him by someone who is not qualified to give him the correct information.

VARIOUS METHODS OF TRAINING WHILE ON THE JOB

Years ago, before industrial training programs reached their present stature, the employee was assigned to a job, given a few brief instructions by the foreman and then was left to shift for himself. When he encountered a problem which made it impossible for him to proceed, he asked his foreman for assistance, or, if the foreman was not available—as was often the case—turned to a fellow-worker for aid. While in either case there was a considerable loss of time involved, the latter practice was particularly bad since the new employee picked up many of the poor work habits which the older employee had developed over the years.

Today most progressive companies provide for a training period ranging from a day to several weeks in length, depending upon the job difficulty, during which the new employee receives instruction in the proper method of doing the job from either an experienced operator-trainer or a full-time trainer. The former is to be preferred when the number of new employees fluctuates because the trainer when not training is a regular operator, thus keeping the overhead cost down. This on-the-job training is particularly important when the employee is working under an incentive plan or operating an expensive piece of machinery where standard production must be reached within a short period in order to bring the employee's earnings up to par and keep the overhead cost per unit within proper limits.

From a quality-control standpoint, the learning of correct work habits and the proper steps to take in performing the job, as well as how to avoid the making of scrap, is a most important factor in so far as personnel is concerned. This training must be repeated in many cases when a periodical review indicates that the employee has deviated from the procedures which he was taught to follow originally.

INDIVIDUAL PERFORMANCE IS EVALUATED REGULARLY

The principles of quality control are followed with respect to personnel in the technique of job performance review more so than in any of the other techniques covered by this paper with the possible exception of employee testing. Just as samples of the manufactured products are inspected by means of gauges or other measuring instruments, at intervals to determine whether the process is holding its own with respect to the specified quality limits, so is the performance of the individuals who are engaged in the various operations evaluated at regular intervals for similar reasons. This review of personnel job performance is commonly referred to as merit rating, merit review, performance review, and so forth. While in many respects, as with other phases of quality control, this technique is still in its infancy, it is found today in most of the progressive companies.

Job performance review, as this technique will be referred to in this article, serves the following three major purposes: (1) To provide an indication of merited salary increases; (2) To indicate in what areas additional training is required; and (3) To indicate which employees are promotional prospects.

While the principle applies to jobs in all levels of the organization, in practice the incumbents of "white collar" jobs have their performance reviewed in more companies than do those of manual or "blue collar" jobs. This is probably due to a considerable extent to the fact that manual workers are usually paid on a piece rate basis or on a single day-rate basis as compared with the salary ranges (from minimum to maximum) which exist for "white collar jobs." In addition, the fact that today a large proportion of the manual workers in large manufacturing and service companies are unionized has tended to limit the application of the job performance review technique insofar as this type of employee is concerned, with the result that seniority has replaced ability as the principal criterion of promotability in many companies.

IMMEDIATE SUPERIOR IS BEST PERSON TO REVIEW EMPLOYEE'S JOB

An employee's job performance is usually reviewed by his immediate supervisor, who is the person best qualified to do this. This review is usually checked by the person to whom the supervisor reports in order to obtain at least two separate points of view. This practice may be compared to the checking of the inspectors' work by the check inspector in so far as manufactured products are concerned.

Just as the inspectors in the plant are furnished with gauges and measuring instruments to check the quality of the manufactured product, the

job performance reviewers, or raters as they are often referred to, are furnished with rating forms to assist them in determining to what extent the employees under their direction are fulfilling the requirements of their jobs. It should be borne in mind that such forms should be tailor-made for the particular company, or even subdivision of a company, in which they are to be used. Otherwise, the situation of trying to fit the round peg into the square hole arises and the technique of merit is blamed for the poor results instead of the unskilled technicians.

The training of the raters is a must if valid judgments of employees' performance are to be obtained. This training must be done at the time the rater is first introduced to the technique and periodically thereafter, preferably immediately preceding or following the time at which the ratings are made. Regardless of how good the rating form is, it is the raters who in the last analysis make or break the performance review program.

Insofar as the timing of ratings is concerned, there is no hard and fast policy which applies under all circumstances. For example, it is often found desirable to rate all of the members of a large clerical group at the same time in order to take advantage of the opportunity for comparing the ratings of personnel performing the same jobs, that is, typists, billers, telephone operators, thus afforded. On the other hand, it is usually found more desirable to rate the performance of executive personnel on the anniversary date of their employment in their present positions in view of the fact that it is very difficult to compare their jobs with each other.

With respect to the scoring of personnel performance reviews, the same differences of opinion exist among the "experts" with respect to numerical versus non-numerical or profile scoring as exists in the related technique of job evaluation. Suffice to say that, as Dr. Juan points out under Systems of Rating Quality of Product in his book *Management of Inspection and Quality Control*, committees will often spend long hours debating such points whereas this item is only a minor one of the many decisions which must be made in any quality rating plan. It has been the writer's experience in working with both types of systems in personnel rating that when a numerical scoring system is used, there is a tendency for the raters and ratees to concentrate on the over-all numerical "score" and to neglect the individual factors score which indicates the ratee's strength and weakness—this is particularly true where the ratee's salary depends upon the result of the performance review.

Just as it is important that when inspectors find a defective product being manufactured they call it to the attention of the operators, so should the rater discuss the ratings of his employees with them as soon as they have been returned to him by the reviewer. This discussion of the ratings between the rater and ratee is one of the most important, if

not *the* most important, phases of the performance review program and is probably the one which is often handled most ineffectually, principally, perhaps, because of the difficulty of checking it. As a matter of fact, many companies which have performance review plans in effect make no provision for the discussion of the ratings with the individual rated.

HOW THE EMPLOYEES' RATING REVIEWS SHOULD BE ANALYZED; BY WHOM

After the rating forms have been returned to a central source, usually the personnel department, when the reviews with the employees rated have been completed, the results of the ratings are analyzed, for several reasons. In the first place, a chart of over-all ratings is prepared to show the relationship between the ratings of employees on similar or related jobs. The degree of agreement between the actual distribution of the rating results and the well-known "bell" curve of normal distribution is a measure of the validity of the rating scales or forms. In most cases in actual practice, perfect agreement is not found because of distortions of the samples due to employment screening, training, smallness of groups, etc.

Similar charts of each rater's results are often prepared where the number of employees involved is sufficiently great in order to determine whether there is a reasonable amount of distinction among the employees' performance indicated. A definite slew to the right usually indicates a high rater while one to the left indicates the opposite, in either of which case further training of the rater is indicated.

CHARTS USED IN ANALYSIS OF PERFORMANCE FACTORS

In addition to charts of the over-all ratings, similar charts are usually prepared for the ratings on each separate performance factor, such as accuracy, cooperation, job knowledge, etc., in order to determine whether they are furnishing significant results. Such an analysis of factors provided significant data when a performance review form for supervisory jobs was developed. In this case, an analysis of the rating results (numerical scores from weighted factors) obtained in two ratings of several hundred supervisors showed that a 60-factor form could be reduced to eight factors and eight questions without reducing the effectiveness of the rating, by eliminating insignificant factors and combining others which differed to a very slight extent.

Whereas a centralized group of trained quality control technicians are

needed to develop, co-ordinate, and analyze results of material quality control programs, a similar group of personnel technicians perform the same function in the field of personnel administration. In the latter case, however, the cooperation of the line organization is probably even more important in order to assure the success of the program than it is in the former.

While practically every person in the personnel department in a position of any importance has some responsibility for personnel quality control, the actual development and administration of the techniques described in the foregoing sections of this paper are usually the responsibility of the following groups: employment, medical, training, and wage and salary.

Obviously, the screening techniques are carried out by the employment group along with induction whereas the medical group handles medical examinations and the training group handles training. Because of the fact that the results of a job performance review are usually used as a criterion in connection with the granting of wage increases, the responsibility for the administration of these reviews is often included in the wage and salary group. However, because of the close relationship between this technique and those of testing, training, placement, etc., the groups handling these functions review the results of the reviews and collaborate in any changes that are made.

The foregoing sections of this article dealt primarily with a comparison between quality control with respect to manufactured products and with respect to personnel and with the techniques used for achieving the latter. It is evident, therefore, that quality control principles are applicable in many fields.

One important factor which should be kept uppermost in mind by those engaged in any phase of personnel quality control or by those contemplating the initiating of any of the techniques involved is that they are dealing with human beings rather than with machines or other inanimate objects. Human nature being what it is, there are no two persons exactly alike and their differences must be recognized much more so than minor differences in material things. Just as quality-mindedness must be instilled in the minds of all employees of a company, regardless of position, so must human-relations-mindedness be similarly instilled.

Much of the responsibility for developing this attitude insofar as personnel quality control is concerned, rests with the company's personnel department since it is in a position to exert the greatest single influence on the company's personnel in this respect. If a company whose top management is really human-relations minded develops a competent staff of personnel technicians and gives them the necessary authority commensurable with their responsibility, results in the form of improved quality of personnel should be evident in a relatively short time.

38. HUMAN PROBLEMS WITH BUDGETS

Chris Argyris*

Budgets are utilized as pressure devices for increasing efficiency but at the same time tend to generate forces which in the long run decrease efficiency. The various conflicts, misunderstandings, and cross-purposes that develop between persons involved in various phases of the budgetary process are discussed at some length based on a survey in depth of three plants.

Budgets are accounting techniques designed to control costs through *people*. As such their impact is felt by everyone in the organization. They are continuously being brought into the picture when anyone is trying to determine, plan, and implement an organizational policy or practice. Moreover, budgets frequently serve as a basis for rewarding and penalizing those in the organization. Failure to meet the budget in many plants invites much punishment; success, much reward.

Because budgets affect people so directly, it seems appropriate to ask ourselves some questions about them. What are the effects of budgets on the human relationships in the organization? How well are budgets accomplishing their practical purposes? How can the use of budgets be improved to make them more effective? This article reports some of the results of a pilot study designed to suggest answers to questions like these.

BACKGROUND INFORMATION

To keep the research problem within manageable limits, it was decided to focus primarily on the effects of *manufacturing* budgets (e.g., production, waste, and error budgets) upon the *front-line supervisor*. To this end our research group made a field study of three small plants (i.e., with less than 1,500 employees) manufacturing both "custom made" products and products "for stock"—all three of them unionized and covering the full range from highly skilled to nonskilled workers. (None of the plants, it

* From *Harvard Business Review*, XXXI, 1 (1953), 97-110. Reprinted by permission of the *Harvard Business Review*.

Author's Note: The research which led to this article was carried out under the auspices of the Controllership Foundation. Dr. Schuyler D. Hoslett, Director of Executive Program in Business Administration, Columbia University, was in over-all charge of the project. Mr. Frank B. Miller of Cornell University assisted me. The entire research is reported in *The Impact of Budgets on People* (New York, Controllership Foundation, 1952).

should be noted, has a supervisory incentive system as part of its budget system.) In one plant we interviewed a 100% sample of front-line supervisors, in another a 90% sample, and in the third a 25% sample, using non-directive questions; and in addition we observed many of the same supervisors in action.

Just in case my observations suggest that I have little sympathy for budgets, let me say that any such impression stems from the negative reactions which the interviews themselves produced. This is perhaps inevitable, when one keeps the following points about budgets in mind:

1. Budgets are, first of all, evaluation instruments. Because they tend to set goals against which to measure people, they naturally are complained about.
2. Budgets are one of the few evaluation processes that are always in writing and therefore concrete. Thus, some of the supervisors tend to use budgets as "whipping posts" in order to release their feelings about many other (often totally unrelated) problems.
3. Budgets are thought of as pressure devices. As such they produce the same kind of unfavorable reactions as do other kinds of pressure regardless of origin. In fact, the analysis I shall make of the effects of management pressure upon supervisors is not necessarily limited to budgets. For example, a company "saddled" with a domineering executive but which has no budget may well be affected by the same factors as those reported herein.

PREPARATION OF BUDGETS

The process of preparing a manufacturing budget is much the same in all plants:

It usually starts with a meeting of the controller, the assistant controller, and a group of top-management members to determine over-all financial goals for the company in the forthcoming year. The controller's staff then translates the financial goals into the detailed breakdowns required for departmental budgets. This preliminary budget is then sent to all superintendents, who are asked to scrutinize it carefully and report any alterations they wish to make.

During their period of scrutiny, the superintendents (middle management) discuss the budget with their own supervisory group in a series of meetings. The first-line foremen do not usually take part in these discussions, although their ideas are requested when the superintendents deem it desirable.

Once the superintendents have their budget modifications clearly in mind, a meeting is held with the controller and his staff. Both parties come to the meeting "armed to the teeth" with "ammunition" to back their demands. After the disagreements are resolved, all parties sign the new budget proposal. The superintendents return to their offices, awaiting the new budget and the expected drive to "put it over."

So much for background information. Now, let us turn to a discussion of some of the effects budgets seem to have upon people. This discussion will be limited to five major areas: (1) the problem resulting from the fact that budgets are used as a pressure device, (2) the problem of the budget supervisor's success and the factory supervisor's failure, (3) the

problem of department-centered supervisors, (4) the problem resulting from the fact that budgets are used as a medium for personality expression, and (5) a case example of human problems related to budgets. In conclusion, some lines of action for management to follow in meeting these problems will be suggested.

1. AS A PRESSURE DEVICE

One of the most common of the factory supervisors' assumptions about budgets is that they can be used as a pressure device to increase production efficiency. Finance people also admit to the attitude that budgets help "keep employees on the ball" by raising their goals and increasing their motivation. The problem of the effects of pressure applied through budgets seems to be at the core of the budget problem.

CAUSES OF PRESSURE

Employees believe that pressure from above is due to top management's assumption that most workers are basically or inherently lazy. Employees also believe that top management thinks the workers do not have enough motivation of their own to do the best possible job. And first-line supervisors have the same beliefs.

Interviews with top-management officials revealed that these employee beliefs were not totally unfounded, as a few quotations from some of the top management (both line and finance) make clear:

> "I'll tell you my honest opinion. About 5% of the people work, 10% of the people think they work, and the other 85% would rather die than work!"
>
> "I think there is a definite need for more pressure. People have to be needled a bit. Man is inherently lazy, and if we could only increase the pressure, I think the budget system would be more effective."
>
> "There are lots of workers in this plant, hundreds of them, who don't have the capacity to do things other than what they're doing. And they're lazy! They might be able to develop some capacities, although I think there are a lot of them who couldn't even if they wanted to. But *they don't even have the desire*."

Such feelings, even if never openly expressed to the employees, filter through to them in very subtle ways. Once they sense that feelings of this kind exist in top management, they may become very resentful. Some supervisors, who apparently felt that budgets reflected this situation, expressed warnings like the following:

> "The employees have an established conception of a fair output. Now, if you believe, like most financial people do, that the average worker is out to cheat the company all the time, I give up."
>
> "Managements ought to change their attitudes that employees are out to get them."
>
> "Well, I guess they think that we need this needling. But *I* don't think so."

EFFECTS OF PRESSURE

How do people react to pressure? In the three plants studied factory supervisors felt they were working under pressure and that the budget was the principal instrument of pressure. Management exerts pressure on the work force in many ways, of course; budgets are but one way. Being concrete, however, budgets seem to serve as a medium through which the total effects of management pressure are best expressed. As such they become an excellent focal point for studying the effect of pressure on people in a working organization.

To help clarify what happens when management "puts on the pressure" let us think of a situation in specific terms:

> For the sake of illustration, assume that the technical efficiency of a plant is at a maximum and that human efficiency, or effort, has to be increased if production is to be raised. The work force of the plant is producing at 70% of its efficiency. Since the level of efficiency is 70%, there must be certain forces which keep it from falling below 70% and certain forces which prevent it from going above 70%.
>
> Some of the forces which keep it from falling below 70% are: (a) budget talks to foremen; (b) red circling of poor showing of the departments in the budget results; (c) production drives; (d) pep talks by supervisors using budgets as evidence; (e) threat of reprimand if the budget is not met; and (f) threat of feelings of failure if budget is not met.
>
> Some of the forces which prevent efficiency from going above 70% are: (a) informal agreements among employees not to produce more; (b) fear of loss of job if efficiency increases; (c) foreman (union) agreements against "speedups"; (d) abilities of individual employees; (e) abilities of work teams as a whole.

In our example the level of production is stable; therefore both sets of forces are equal in strength. Suppose that top management decides to increase production. Usually, thought is immediately given to adding more factors to those that help increase production. The logic is that if these forces can be strengthened, they overcome the forces which tend to prevent efficiency from rising, and thereby increase production.

Budgets play an important part in this new "push." Finance people are usually asked to scrutinize all budgets carefully. They are directed to cut out all "the lace and niceties" and "get down to essentials." In short, a new pressure upwards is expressed somewhere in the new budgets in terms of a "tighter" figure.

The results may be as expected. Human efficiency rises, say, 10%, and production is increased. A new level of efficiency is stabilized at 80%.

But actually something else has occurred concurrently with this new push—something which management may not perceive. Since the level of human efficiency has now been stabilized at 80%, presumably factors that keep production down also have increased until they equal the factors that tend to increase production. Therefore, coupled with an increase in

production, the plant also acquires an increase in forces directed in the opposite direction. People and groups are now trying harder (consciously or unconsciously) to keep production at this new level and prevent it from rising again.

It is not difficult to see what happens. Tension begins to mount. People become uneasy and suspicious. They increase the informal pressure to keep production at the new level. Any new increase will have to be "paid for" by management in "free" tickets to football games, slowdowns, strikes, etc.

Moreover, management has to work harder to keep the new strength of the forces which tend to drag down efficiency from overwhelming the forces which resulted in increased production. It will find itself constantly looking for new ideas, new methods to keep the production at the present level. Any slight decrease in pressure on its part will result in an immediate reduction in production.

Finally, this constant increasing pressure from top management for greater production may lead to long-term negative results. People living under these conditions tend to become suspicious of every new move management makes to increase production, particularly budgets.

CREATION OF GROUPS

An increase in tension, resentment, suspicion, fear, and mistrust may not be the only result of ever stronger management pressures transmitted to supervisors and, in turn, to employees. We know, from psychological research, that people can stand only a certain amount of pressure. After this point is passed, it becomes intolerable to an individual. We also know that one method people use to reduce the effect of the pressure (assuming that the employees cannot reduce the pressure itself) is to join groups, which help absorb much of the pressure and thus relieve the individual personally.

The process of individuals' joining groups to relieve themselves of pressure is not a simple one. It does not occur overnight. The development of a group on such a basis seems to go through the following general stages:

1. First, the individuals sense an increase in pressure.
2. Then they begin to see definite evidences of the pressure. They not only feel it; they can point to it.
3. Since they feel this pressure is on them personally, they begin to experience tension and general uneasiness.
4. Next, they usually "feel out" their fellow workers to see if they too sense the pressure.
5. Finding out that others have noted the pressure, they begin to feel more at ease. It helps to be able to say, "I'm not the only one."

6. Finally, they realize that they can acquire emotional support from each other by becoming a group. Furthermore, they can "blow their top" about this pressure in front of their group.

Gradually, therefore, the individuals become a group because in so doing they are able to satisfy their need to (a) reduce the pressure on each individual; (b) get rid of tension; (c) feel more secure by belonging to a group which can counteract the pressure. Now, let us take a look at an actual example of the way this works out:

One of the plants we studied was under the "iron rule" of a top-management executive known to the employees as "old thunder and guts" or "the whip." Many of the people interviewed in this plant mentioned what a terrible place it was in which to work. The pressure from above was high, and no one, reported the interviewees, knew exactly why it was high. Furthermore, they saw no sign that it would "let up."

As the pressure became intolerable for these people, some interesting things began to happen. Informal meetings between employees occurred with the pressure as the main topic of conversation. At first it was mentioned through jokes and "friendly gripes," but it soon became an increasing source of grievance. The private meetings expanded, and the groups became as high as eight in number. When asked why they attended these meetings, the interviewees answered: "It made me feel good to know I wasn't the only one." "If you're going through hell, it's nice to know that the others are also." And so on.

In due time the informal group feelings grew stronger, and the friendships created began to expand from the locker room to the members' homes, the local bars, and other social situations. Thus, out of these contacts there developed strong bonds which, although they were originally created by the pressure from management, had by now become re-enforced and stabilized by many other social activities.

The end result, judging by the interview material, was that the new groups became extremely cohesive and "well-knit." This high degree of solidarity had the effect of permitting these people to feel that they were now free to gripe against management because they had the support and sanction of their group.

In short, new cohesive groups developed to *combat* management pressure. In a sense, the people had learned that they could be happier if they combined against it.

Suppose now that top management, aware of the tensions which have been generated and the groups which have been formed, seeks to reduce the pressure. The emphasis on budgets is relaxed. Perhaps even the standards are "loosened." Does this then destroy the group? After all, its primary reason for existence was to combat the pressure; and now that the pressure is gone, the group should, according to common sense, disintegrate.

But apparently the group continues to exist. Just why this is so cannot be stated conclusively. In matters like this, we must make use in part of inference. Conceivably one or more of these three factors could operate to keep the group in existence:

1. There may be a "time lag" between the moment management announces the new policy and the time the workers put it into effect. However, no direct evidence was obtained to substantiate this possibility.

2. The individuals have made a new and satisfactory adjustment with one another. They have helped to satisfy each other's needs. They are, as the social scientist would say, "in equilibrium" with each other. Any attempt to destroy this balance will tend to be resisted even if the attempt represents an elimination of a "bad" or unhealthy set of conditions. People have *created* a stable pattern of life, and they will resist a change in this pattern.

This resistance to change is not unusual. Experimental evidence suggests that cohesive groups will tend to resist attempts which may destroy their solidarity regardless of where these attempts originate (i.e., whether they come from the members themselves or from people outside the group).

The top executives in two of the plants studied presented us with some vivid evidence of this factor. Under the influence of "high-pressure" leadership in these plants the employees seemed to become more suspicious of all management executives and at the same time more rigid and "harder to get along with." Issues which had never previously erupted were channeled through the organizational ladder as being "red-hot" grievances. Moreover, employees seemed to show great fear of any new changes. This was true even when they were assured that such changes would not occur until all their arguments had been heard and appropriate steps taken wherever possible.

The top executives summed up the situation with such phrases as: "Things weren't like they used to be." "We weren't as close as we used to be." "To be honest with you something smelled somewhere, but I was not sure what." When asked if they felt the union might be the cause of their problem, they were quick to reply that the plants were organized long before these unhappy developments.

3. The individuals in the group may fear that pressure will come again in the future. Because of this feeling they will tend to create unreal conditions or to exaggerate existing conditions just so they can rationalize to themselves that pressure still exists and therefore that the need for the group also exists.

Here again we found substantiating evidence. Some of the employees admitted in their interviews that, while management had officially announced a new policy of less pressure and more participation, they were suspicious about the participation and considered it a new way to cover up the old pressure. Others admitted freely that they spread unverified rumors about management intentions. In short, employees were doing their best to create *in their own minds* the conditions that would permit them to feel that pressure was still present and the need for the group still strong.

PRESSURE ON SUPERVISORS

But what about the supervisor, particularly the front-line supervisor or foreman? Strong pressures also converge upon him. How does he protect himself from these pressures?

He cannot join a group against management, as his work force does. For one thing, he probably has at least partially identified himself with management. For another, he may be trying to advance in the hierarchy. Naturally, he would not help his chances for advancement if he joined an antimanagement group.

The evidence obtained from our study seems to indicate that the line supervisor cannot pass all the pressure he feels along to his workers. Time and time again factory supervisors stated that passing the pressure down would only create conflict and trouble, which in turn would lead to a decrease in production.

The question thus arises: Where does the pressure go? How do the supervisors relieve themselves of at least some of it? There is evidence to suggest at least three ways in which pressure is handled by the supervisors:

1. *Interdepartmental strife*—Some foremen seek release from pressure by continuously trying to blame others for the troubles that exist. In the three plants observed, much time was spent by certain factory supervisors in trying to lay the blame for errors and problems on their fellow supervisors. As one foreman put it, "They are trying to throw the cat in each other's backyard."
2. *Staff versus factory strife*—Foremen also try to diminish pressure by blaming the budget people, production-control people, and salesmen for their problems.
3. *"Internalizing" pressure*—Many supervisors who do not complain about the pressure have in reality "internalized" it and, in a sense, made it a part of themselves. Such damming up of pressure can affect supervisors in at least two different ways:

(a) Supervisor A is quiet, relatively nonemotional, seldom expresses his negative feelings to anyone, but at the same time he works excessively. He can be found at his desk long after the others have gone home. He often draws the comment, "That guy works himself to death."

(b) Supervisor B is nervous, always running around "checking up" on all his employees. He usually talks fast, gives one the impression that he is "selling" himself and his job when interviewed. He is forever picking up the phone, barking commands, and requesting prompt action.

One type "A" supervisor made the following remark:

"I'm just about sick and tired of the damn pressure in industry. It isn't human; moreover it's unnecessary. I've learned my lesson. I'm going to do my job as well as I can and not let things bother me. Some of the men around here work with the speed of a man 'hell bent for election.' Not me. And to be quite honest with you, I think I get as much done as they do."

After some further questioning, the same supervisor admitted that he would "like to tell a few people off around here. Believe me, at times I'd like to tear into. . . ." With a smile he speculated, "I wonder what they would think of me. I bet I'd surprise the daylights out of them." (There is little doubt that this supervisor would surprise those he threatens to attack. In fact, he would probably also surprise himself.)

Although we found quite a few examples of type "A" in our study, there were even more of type "B." One budget man of the "B" variety, after substantial clinical interviewing, admitted that he was working too hard. But he quickly added that he *had* to overwork himself; and that, if he didn't, the organization would not be in as sound a financial position as it is now. He sadly lamented the "fact" that there was no subordinate

capable of replacing him. He said that he didn't think any of the likely candidates would worry about the job as he does. Yet, interestingly enough, he seemed greatly relieved when, after his admission that he really did want to take it easy, the interviewer did not respond with astonishment.

Both of these types are expressions of tensions and pent-up emotions that have been internalized. People working under too much pressure finally are forced to "take it easy," or they find themselves with ulcers or a nervous breakdown.

But that is not the end of the problem. Constant tension leads to frustration. A person who has become frustrated no longer operates as effectively as he used to. He finds that he tends to forget things he used to remember. Work that he once did with pleasure he now delegates to someone else. He is not able to make decisions as fast as previously. Now he finds he has to take a walk or get a cup of coffee—anything to "get away from it all."

WHEN TIMES ARE BAD

Most finance people agreed that budgets are used with greatest force when times are bad. In their experience, as soon as sales and profits decrease and the economic future begins to look black, budgets are immediately emphasized and strengthened.

What happens in such a situation? The foreman, who is already living in a pressure-laden and tension-filled world, suddenly finds himself (with others) in a bad economic period. All the stresses and strains (at home as well as in the plant) which are associated with poor economic conditions are added to the already existing tension-creating factors in his life. To make matters worse, management usually adds a third set of such factors by applying all sorts of pressure on him through budgeting.

The results are immediately evident. Extreme application to work or extreme aggression become "natural"—part of the "human nature" of the supervisor. His consequent attempts to alleviate some of the factors causing the tension may lead to quick, ill-conceived, confused, or violent action.

Withdrawal, apathy, indifference are other results of such stresses and strains. Rumors begin to fly; mistrust, suspicion, and intolerance grow fast. In short, conflict, tension, and unhappiness become the key characteristics of the supervisor's life.

ANOTHER WAY TO RAISE PRODUCTION

We have seen how, in order to increase human efficiency from 70% to 80%, pressure was applied through the medium of the budget. Adding

to the forces which increase efficiency also strengthened the forces which decrease efficiency. Employees sought to relieve themselves of increased tension by combining into groups. Front-line supervisors, prevented from grouping, either "took it out" on other foremen or on the budget people, or else bottled it up within themselves. It seems possible that by such a procedure management has mortgaged the future to bring about an immediate increase in efficiency. This raises the question: Is there any other way to increase production?

The necessity for constantly increasing efficiency is a basic fact of business life. Yet increasing efficiency generates forces which in the long run decrease efficiency, and the problem is still unsolved; it may be worse than ever. So perhaps more can be gained by concentrating on weakening those forces which tend to decrease efficiency, rather than strengthening the forces which tend to increase efficiency. Basically, the only way out is to obtain the participation of the employees themselves in alleviating the factors that they have created to help keep production down.

To this end, conferences and interviews can be conducted where the employees have an opportunity to express their fears of increased production and their reasons for preventing production from rising. Needless to say, the executives in charge of such meetings should be sensitive to and aware of the factors that can cause resistances to changes. They should also be skilled in conference technique. For example, they may find it more profitable to prevent any vote by the group on a new idea, even a majority vote in acceptance. A vote in any group simply points up the fact that the group is divided. And since there may be employees who, as a result of the vote, are forced to do more than they consider a fair day's work, they are likely to have inner resistances to the changes and be the cause of further trouble. A more fruitful and lasting objective would be for the executives to help the group members define an objective upon which they all can agree.

In other words, the primary aim of such participation is to attempt to obtain acceptance of a new idea or change by removing the resisting forces within the individuals rather than by applying outside pressure.

SUCCESS AND FAILURE

Students of human relations agree that most people want to feel a sense of achievement. We observe people constantly defining social and psychological goals, struggling to meet them, and, as they meet them, feeling successful.

Budget and factory supervisors are no exception. The typical budget or finance supervisor does his work as best he can. He hopes and expects just praise of this work from *his superior*. It is the "boss" who will eventually

say "well done," or recommend a promotion. Most of his success comes, therefore, from his superior's evaluation. The situation is the same for the factory supervisor. He also desires success; and, like the finance supervisor, much of his success also derives from the comments and behavior of the "boss." In short, both finance and factory supervisors are oriented toward the top for an evaluation of how well they are doing their jobs.

But here is where the trouble comes in: success for budget supervisors means failure for factory supervisors.

ROLE OF BUDGET SUPERVISORS

Our interviewers suggested that the budget people perceive their role as being "the watchdog of the company." They are always trying to improve the situation in the plant. As one finance supervisor said, "*Always* there is room to make it better." Or as a controller said, when describing a successful budget supervisor, "The budget man has made an excellent contribution to this plant. He's found a lot of things that were *sour*. You might say a good budget man . . . lets top management know if anything is *wrong*."

In other words, the success of the finance men derives from finding errors, weaknesses, and faults that exist in the plant. But when they discover such conditions, in effect they also are singling out a "guilty party" and implicitly, at least, placing him in failure. Naturally, any comment that "things aren't going along as well as they could in your department" tends to make the particular foreman feel he is deficient.

To be sure, such an occurrence will not make every factory supervisor feel he has failed. Some of the foremen we studied apparently do not worry much about their jobs. The one who really feels the failure is the foreman who is *highly interested in doing a good job.*

The implications of this phenomenon are interesting. It means that management people need to think twice when they discipline their supervisors; they need to study the differential effects of discipline upon supervisors. Otherwise they may create a situation in which the supervisor who "doesn't give two hoots" about his job will be unaffected by the discipline while the supervisor who is loyal will suffer unduly.

Methods for rewarding supervisors may also need to be re-examined. The same objective increase in salary may tend to have different effects upon those receiving this increase. Thus, a hard-working supervisor may feel hurt when he realizes that his "excellent" raise has also gone to supervisors who show in their work that they have no loyalty to the company.

REPORTING FOREMEN'S SHORTCOMINGS

The way in which foremen's shortcomings are reported also is important.

Let us assume that a finance man discovers an error in a particular foreman's department. How is this error reported? Does the finance man go directly to the factory foreman? In the plants studied the answer, usually, is no.

The finance man cannot take the "shortest" route between the foreman and himself. For one reason, it may be a violation of policy for staff personnel to go directly to line personnel. Even more important (from a human point of view), the finance man achieves his success when *his boss* knows he is finding errors. But his boss would never know how good a job he is doing unless he brought attention to it. In short, perhaps because of organizational regulations but basically because the measure of success in industry is derived from above, the finance man usually takes his findings to his own boss, who in turn gives them to his superior, and so on up the line and across and down into the factory line structure.

Taking the long way around has at least one more positive value for finance people. Those in middle and top management also derive some success in being able to go to the plant manager and point to some newly discovered weaknesses in the factory. Therefore, all the interested people up the entire finance structure obtain some sense of satisfaction.

But how about the factory people? The answer seems evident. In such a situation, the foreman experiences the negative feelings not only of being wrong but also of knowing that his superiors know it, and that he has placed them in an undesirable position.

Finally, to add insult to injury, the entire incident is made permanent and exhibited to the plant officials by being placed in some budget report which is to be, or has been, circulated through many top channels.

EFFECTS OF FAILURE ON PEOPLE

One might ask: What effects has this kind of failure upon an individual? If the results were insignificant, obviously we would not be concerned. Unfortunately, such is not the case. Feelings of failure can have devastating effects upon an individual, his work, and his relationships with others.

Lippitt and Bradford, reporting on some ingenious scientific experiments conducted on the subject of success and failure, state that people who experience failures tend to:

1. Lose interest in their work,
2. Lower their standards of achievement,
3. Lose confidence in themselves,
4. Give up quickly,
5. Fear any new task and refuse to try new methods or accept new jobs,
6. Expect failure,
7. Escape from failure by daydreaming,
8. Increase their difficulty in working with others,
9. Develop a tendency to blame others, to be overcritical of other's work, and to get into trouble with other employees.

We found many instances of supervisors who were experiencing failure and who exhibited these characteristics. Some of them were apathetic and did not care much for their work; they would, however, break out into a smile when they talked about fishing, vacations, the company recreational events, or any other activity which took place *outside* the plant environment. Other supervisors blamed everyone but themselves for their problems and insisted that in the industrial world one had to "look out for himself, for it was dog eat dog." Still others expressed little confidence in themselves or their subordinates; they claimed they could trust no one, and that life in the plant was a pretty dismal affair. (Of course other factors than a sense of failure were also contributing to these attitudes, but the failure aspect was clearly important.)

WALL BETWEEN FINANCE AND FACTORY

At least two more factors operate to place the finance people in the peculiar position which they hold:

1. Since the budget people are always looking for faults, they begin to develop a philosophy of life in which their symbol for success is not the error discovered but the very *thought* of the discovery of a possible new error.
2. The realization of the peculiar position in which they are placed leads budget people into a tendency to become defensive about their work. Though basically they may not like putting people in embarrassing positions, they have to. So they react negatively to queries about their methods, their language, their books. Sometimes they even use their technical know-how and jargon to confuse the factory people. As one budget man suggested, "After all, if the foremen don't know anything about budgets, how can they criticize them?"

Thus, the ignorance of the factory people concerning budgets may serve as a wall behind which the finance people may work unmolested, and one of the major causes of insecurity among factory supervisors concerning budgets (i.e., "we can't understand them") becomes one of the primary factors of security for the budget people.

There seems little doubt that the problem of success and failure is a major one. It needs further study. Present research has served merely to identify it.

DEPARTMENT-CENTERED SUPERVISORS

We have already shown that supervisors are partially evaluated by budget records. The factory supervisor who desires to be known as efficient and effective must make certain that his daily, weekly, monthly, and quarterly results compare favorably with the predicted results defined by the budgets. In short, a factory supervisor will feel successful, other things being equal, when he "meets his budget."

This idea of meeting the budget is crucial. For the budget, measuring the effectiveness of a supervisor as it does, continually emphasizes to each supervisor the importance of *his*, and *primarily* his, department. The budget records he receives show *his* department's mistakes, *his* department's errors, and *his* department's production—all *against* the other departments.

Interviews with the factory supervisors left little doubt that they were department-centered in outlook rather than plant-centered. Typical comments were:

"The other day, I received an order to do a job, but no requisition. I called up production control and asked what was going on. I said to them, 'Why didn't I get the requisition on that order?' They started to give excuses. Sure, they didn't worry. *This was my job, just like I don't have to worry when the other departments stand still.*"

"Each one of us gets *his* own picture when we get the budget results. Even if we got the total picture, it wouldn't mean much to us. We go right for our sheet. . . . As I said, we might get the whole plant picture, *but we're primarily interested in our own department.*"

"I don't get a picture of the other people's budgets in this place, and I don't think I need one or even want one. My main responsibility is in this here outfit of mine. *Nowhere else.* So, let them worry about their problem, and I'll worry about mine."

The philosophy which budgets foster may be expressed this way: if every supervisor worries about his own department, there will be no trouble in the plant. Therefore, if each supervisor is made primarily responsible for the production aspect of his part of the whole picture, no problems will arise.

Such a philosophy overlooks an extremely important point. An organization is something different from the sum of the individual parts. The parts of an organization exist in certain *relationships* with each other, and it is these relationships which create the difference. One cannot conceive of "adding" together the parts of an organization any more than adding together the hundreds of pieces that make up a watch in order to make it run. The crucial problem is to place the parts in correct relationship to each other.

Without laboring the point it seems clear that important relationships between departments are disregarded by overemphasizing the individual departments. If everyone does his utmost to make certain that his own department is functioning correctly, but at the same time pays no attention to the functioning of his department in relation to others, trouble will still arise. And then, particularly in plants which make forceful use of budgets, with the supervisors trying to blame someone else so their departments are not the ones to be penalized, the conflict begins.

CONTROLLING CONFLICTS

But does not control of the relationships among departments rest with the plant manager or some higher authority? Is he not able, from his high position, to control the conflict among departments? The crux of the matter is that this *is* all the leader can do—*control* conflict. (He is unable to eliminate it, since its deep-rooted causes are not within his reach.) And because the supervisors know he controls conflict, they increasingly look to him to break up a fight or settle a dispute. Furthermore, the more successful the top leader is in this respect, the less the supervisors need to worry about cooperation. They soon learn that the leader will solve any interdepartmental problem, and become dependent on him.

Here is an example of the kind of situation that can develop:

In one of the plants studied a mistake was made on a customer order. The customer returned the material to the plant, where the error was corrected, and the material was then sent back to the customer.

The cost of making the correction was nearly $3,000. The error, especially since it was so large, had to be entered in the budget records. Some department had to be charged with the error. But which department? That was the problem.

For two months supervisors of the departments most likely to be blamed waged a continuous campaign to prove their innocence. Each blamed the others. No one wanted the error on *his* record. They spent hundreds of man-hours arguing and debating among themselves. Emotions were aroused; people began calling each other names. Finally, two of the supervisors stopped talking to each other.

By this time the division manager was also in hot water. To charge any supervisor with such an error would certainly invite hostility from that supervisor—hostility which might have further effects in the future. Naturally, the division manager did not want to risk a weakening of his relationships with any of his supervisors. But he had to make a decision.

A meeting was held with the interested supervisors. The problem was discussed, and blame was placed on just about everybody and everything possible. The division manager finally gave up; he decided to charge the error to no department but rather to let the plant as a whole carry the stigma. As he himself explained it, "I thought it might be best to put the whole thing under general factory loss. Or else someone would be hurt."

This case shows that budget records, as administered, foster a narrow viewpoint. They serve as a constant reminder that the important aspect to consider is one's own department, not the over-all good of the plant.

LEADERSHIP PATTERNS

The final problem to be discussed became evident only after a series of interviews with various controllers and top factory officials indicated that

the ways in which people express their interest in budgets, and the ways in which they describe and use them, are directly related to the pattern of leadership they use in their daily industrial life. For example, when a rather domineering, aggressive, "go-getting" top executive was interviewed, his presentation of the problem tended also to be made in a domineering, aggressive, "go-getting" manner.

Therefore, although it is accurate to state that budgets are composed of "cold, nonhuman symbols" (i.e., figures), it is equally valid to state that once human beings use these "nonhuman figures," they project on to them all the emotions and feelings at their command. An incident which occurred in one of the plants studied may illustrate this point:

> At the close of a particularly violent budget meeting in which a top executive had flayed his subordinates needlessly, he ended by saying, "Now, fellows, I'm sorry I got hot. But it's these budget figures—well, you know, I worry about them." The subordinates all nodded their heads to indicate that they understood. They left the meeting room thinking, "Those damn budgets again. *They get the boss all upset.*"

But this kind of interpretation, although highly prevalent when such instances occur, is not at all accurate. It was *not* the budgets that got the boss "all upset." The budgets were merely a medium through which the boss could *express* the fact that he was upset. Obviously budgets *per se* can do nothing. It is the people who use them that cause the behavior observed. Budgets, then, can be used to express one's pattern of leadership.

Because budgets become a medium of personality and leadership expression, and since people's personalities and leadership patterns are different, our research study found a number of methods with which top factory executives used budgets. A few of these methods are illustrated by the following comments made by top factory supervisors:

> "I go to the office and check that budget every day. I can then see how we're meeting it. If it's O.K., I don't say anything. But if it's no good, then I come back here and give the boys a little—well, you know, I needle them a bit."
>
> "I make it a policy to have close contact, human contact, with the people in my department. If I see we're not hitting the budget, I go out and tell them I have $40,000 on the order. Well, they don't know what that $40,000 means. They think it's a lot of money so they get to work. The human factor, that's what is important. If you treat a human being like a human being, you can use them better and get more out of them."
>
> "You know it's a funny thing. If I want my people to read the budget, I don't shove it under their nose. I just lay it on my desk and leave it alone. They'll pick it up without a doubt."

Note how the different ways in which these men use budgets express different patterns of leadership.

A CASE EXAMPLE

A case example may serve to illustrate the use of budgets as media through which the factory executive expresses his personality, and at the same time point up the problem of department-centered supervisors previously discussed.

A top factory executive called a meeting to discuss the problem of waste in his organization, especially the waste in two departments. Present at the meeting were the supervisors of the two departments in question, the supervisor of another department supplying the material to these two departments, two budget people, and the top executive whom we shall call the leader.

Leader: "I've called you fellows down to get some ideas about this waste. I *can't* see why we're having so much waste. I just can't see it. . . . Now, I've called in these two budget men to get some ideas on the subject. Maybe they can tell us how much some of the arguments you're going to give are worth."

Budget man [slightly red, apparently realizing he is putting the supervisors "on the spot"]: "Well, uh, we might be wrong, but I can't see how. There's an entire 0.1% difference, and that's a lot."

Supervisor X to Supervisor Y [trying to see if he can place the blame elsewhere]: "Well, maybe—maybe—some of your boys are throwing away the extra material I sent back to your department."

Supervisor Y [quickly and curtly]: "No, no. We're reworking the extra material and getting it ready to use over again."

Supervisor X [changing his tack]: "Well—you know—I've been thinking, maybe it's those new trainees we have in the plant. Maybe they're the cause for all the waste."

Leader: "I can't understand that. Look here—look at their budget—their waste is low."

The meeting continued for another twenty minutes. It was primarily concerned with the efforts of supervisors X and Y to fix the blame on someone besides themselves. The leader terminated the meeting by saying, "All right, look here, let's get busy on this—all of you—all of *us*, let's do something about it."

Supervisor X left the meeting, flushed, tense, and obviously unhappy. As he passed through the door, he muttered to himself, "Those God damn budgets!"

Supervisor Y hurried down to his area of the plant. He rushed into the office and called his subordinates abruptly, "Joe, Jim, all of you, get over here. I want to speak to you; something is up."

The subordinates came in, all wondering what had occurred. As soon as they had all assembled, the supervisor started: "Look, we've just *got* to get at this waste. It makes me look like hell. Now let's put our heads together and get on the ball."

His subordinates then set to work to locate the causes for the waste. Their methods were interesting. Each one of them *first* checked to see, as one of them put it, "that the group in the other departments aren't cheating us." A confidential statement finally came to Supervisor Y's desk from one of the subordinates to the effect that he had located the cause in Department X.

Supervisor Y became elated, but at the same time was angry at the fact that he had been made to look "sick" at the meeting with the leader. He warned, "I'm going to find out why they are making the waste. I don't mind the short end of the stick as long as it's me that's doing the trouble."

Supervisor Y roared out of his office and headed straight for the office of Supervisor X. The latter saw him coming and braced himself for the onslaught. Y started in, "I found out that it's your boys causing the waste. You bastard, I want to know why. . . ."

"Now you just hold on to your water," cut in X. "Don't get your blood up. I'll tell you. . . ."

And so it went. In this cost-conscious plant, six people on the supervisory level spent many hours trying to place the blame on someone else.

IMPLICATIONS FOR MANAGEMENT

This explanatory research has led to the tentative conclusion that budgets and budgeting can be related to at least four important human relations problems:

1. Budget pressure tends to unite the employees against management, and tends to place the factory supervisor under tension. This tension may lead to inefficiency, aggression, and perhaps a complete breakdown on the part of the supervisor.
2. The finance staff can obtain feelings of success only by finding fault with factory people. These feelings of failure among factory supervisors lead to many human relations problems.
3. The use of budgets as "needlers" by top management tends to make each factory supervisor see only the problem of his own department.
4. Supervisors use budgets as a way of expressing their own patterns of leadership. When this results in people getting hurt, the budget, in itself a neutral thing, often gets blamed.

Now, in the light of these findings, what lines of action should management take? Though the problems obviously are complex, and the research into them exploratory, there do appear to be two areas in which management action may prove fruitful.

PARTICIPATION IN MAKING BUDGETS

The first is in the problem of getting an acceptance of budgets. Interviews with controllers suggest that this area is a crucial one. Time and

time again our research group was told that the best way to gain acceptance is to have the supervisors all participate in the making of the budgets that affect them. In particular the controllers emphasized the need for participation of all key people in instituting any *changes* in budgets, plus the willingness on the controllers' own part to revise their budgets whenever experience indicates it necessary.

The typical controller's insistence on others' participation sounded good to us when we first heard it in our interviews. But after a few minutes of discussion it began to look as if the word "participation" had a rather strange meaning for the controller. One thing in particular happened in *every* interview which led us to believe that we were not thinking of the same thing. After the controller had told us that he insisted on participation, he would then continue by describing his difficulty in getting the supervisors to speak freely. For example:

> "We bring them in, we tell them that we want their frank opinion, but most of them just sit there and nod their heads. We know they're not coming out with exactly how they feel. I guess budgets scare them; some of them don't have too much education. . . . Then we request the line supervisor to sign the new budget, so he can't tell us he didn't accept it. We've found a signature helps an awful lot. If anything goes wrong, they can't come to us, as they often do, and complain. We just show them their signature and remind them they were shown exactly what the budget was made up of. . . ."

Such statements seem to indicate that only "pseudo-participation" is desired by the controller. True participation means that the people can be spontaneous and free in their discussion. Participation, in the real sense of the word, also involves a group decision which leads the group to accept or reject something new. Of course, organizations need to have their supervisors accept the new goals, not reject them; however, if the supervisors do not really accept the new changes but only say they do, then trouble is inevitable. Such halfhearted acceptance makes it necessary for the person who initiated the budget or induced the change, not only to request signatures of the "acceptors" so that they cannot later on deny they "accepted," but to be always on the lookout and apply pressure constantly upon the "acceptors" (through informal talks, meetings, and "educational discussions of accounting").

In other words, if top-management executives are going to use participation, then they should use it in the real sense of the word. Any dilution of the real thing "will taste funny," and people will not like it.

Of course employees cannot participate in all phases of the plant budget. In the typical plant most of the over-all goals of a plant or even a department cannot be set by the members of the plant or the department. But the ways in which these goals are to be accomplished can be decided upon cooperatively by the interested employees. In other words, if top

management has set down a profit goal for the year, then there is not much sense in saying the people actually participated in setting that goal. Nor should management try to get them to feel this is *their* goal in the sense that they created it. But top management can try to make them feel that this is *their* goal in the sense that they participated in a decision to accept it.

We have found that goals are most often accepted if the individual members can come together in a group, freely discuss their opinions concerning these goals, and take part in defining the steps by which these goals will be accomplished.

TRAINING IN HUMAN RELATIONS

The second area in which management action may attack these budget problems is that of training in human relations.

Our interviews with the top controllers constantly brought out the "figure conscious," narrow-minded rigidity of most finance people. Here are some typical criticisms of accountants:

> "Most of them are warped and they have narrow ideas. That, incidentally, is one of the failures of our educational system. We give the fellows all the textbook stuff, but we never teach them how to 'sell' accounting."
>
> "Most of our accountants are narrow and short-sighted. They have a narrow breadth of view. They are what I call 'shiny pants bookkeepers.' They're technicians. They don't know how to handle people."
>
> "I might add, right here and now, that I think one of the worst human problems we have is the poor job of 'selling' that is done with cost records and budgetary control. I think our accounting people are very, very poor in ability to get along with people and to sell them correctly. In fact, I'd go as far as to say that the better the accountant, the poorer he is in human relations. I feel quite strongly about this."

Our findings indicate that, first of all, more instruction in human relations needs to be given to students of cost accounting and budgeting at the college level. We are not prepared to say in what form this instruction can best be integrated into the curriculum, though it appears that such instruction could well be fitted into the traditional case approach of accounting instruction. The accounting and cost-control cases usually present to the student some major technical problems for solution. At the end of each case the student is asked to answer certain questions, and these could well include some issues involving the human relations implications of the problem.

As far as industry's role in training is concerned, I doubt that its main function is to make budget people familiar with the factory people's tasks. To do such a job thoroughly would require a lengthy and extremely expensive training program. Moreover, wherever plants have attempted to have the finance people visit the factory departments and

learn some of the factory people's problems, this training has helped but does not seem to have solved the underlying problem.

Rather, the training should be focused on the underlying problems, not on the superficial difficulties. In line, then, with the major problems identified by our analysis up to this point, the following specific suggestions seem appropriate:

1. The training should be focused to help the finance staff perceive the human implications of the budget system.
2. The training should help show the finance staff the effects of pressure upon people. Thorough discussions seem necessary to understand the advantages and disadvantages of applying such pressure.
3. The training should also include discussions concerning the effects of success and failure. The accounting staff should be helped to perceive their difficult position, namely, that of placing others in failure. They should also be taught the symptoms of people who feel they have failed. Most important, the course should include practical techniques which the finance staff can use to get along better with the factory people, knowing full well that they may place these factory people in failure.
4. Again, the human relations training should include thorough discussions of the human problems related to the department-centeredness of supervisors that is caused by budgets. The finance people should be helped to perceive this department-centeredness as a defense on the part of the factory supervisors rather than as the "narrow-mindedness" which many of them seem to think it is.
5. Finally, there needs to be some instruction in the basic content of human relations as a field of study. This includes the concepts of informal and formal organizations, industrial organizations as social systems, status systems in industrial organizations, and such subjects as interviewing, counseling, and leadership.

Throughout such training the emphasis should be placed upon these supervisors' learning to understand themselves (e.g., their feelings, their values, their prejudices). Once they have been helped to evaluate themselves as human beings, then they are better able to understand their human effects on the others with whom they deal as experts in their particular field.

As for training methods, it follows that the trainer should keep lecturing to a minimum. Case discussion, role-playing, and the member-centered conference are examples of methods which may be profitably used. The conference sessions should be so designed that the leader helps the trainees help themselves. Since the group members are to be the center of their own problem-solving conferences, the leader will take only such roles as a "summarizer of opinions," "clarifier of feelings," and "instigator of free creative thinking."

The emphasis upon understanding oneself is crucial. Time and time again, we found examples where the bases for many so-called organiza-

tional or technical problems were actually rooted in the feelings people held.

The end result is that the financial staff will become more aware of the human problems existing in organizations. Whatever specific steps they take or new attitudes they adopt because of their better understanding of themselves and others in the organization cannot fail to make their use of budgets more constructive, i.e., more effective in terms of long-run results.

39. ESTABLISHING MORE EFFECTIVE MANAGEMENT CONTROLS

T. O. Yntema*

Mr. T. O. Yntema discusses the principles of a control system and the factors which contribute to its over-all success in business.

An effective system of controls in business leads to greater efficiency and more effective coordination of activities. By making possible systematic forecasts, it reduces mistakes, and by increasing the opportunities for delegation, it frees top executives for constructive work. And, of major importance, it strengthens the profit motivation in business.

Such a system is not easy to characterize briefly. If the system is full-fledged, it embodies the major policies of the business, it is a working program for the future, it reveals the financial consequences of alternatives *before* major decisions are made, and it provides means for coordinating and integrating various plans and activities into an efficient operation.

What conditions are essential to the effective operation of the system?

Of primary importance is the role of top management—its active participation and leadership. Top management must see to it that the system expresses its policies in regard to profit objectives, pricing, production schedules, facility planning, and financial planning. It must take the time needed to give careful, intelligent review to the plans of division managers and to follow up on variance of performance from approved plans. And top management must make it clear that rewards in salary, bonus, promotion and commendation are based primarily on performance. The real job of controlling the business belongs to the president, not the controller. No control system can work without the leadership and active participation of top management.

* From *The Management Review*, XLIII, 10 (1954), 683-84. Reprinted by permission of the *American Management Association, Inc.* and *The Management Review*.

Second, if the control system is to be directed toward making profits—as it must—a company of any size and diversity should be subdivided into profit centers. The manager of each profit center should have the responsibility and necessary authority to operate his division as a separate business, subject only to general guidance from broad company policies and, on critical decisions, review by top management. Some of the advantages of such decentralization are fairly obvious: It increases the proportion of important executives charged directly with the responsibility for making a profit; it reduces in size and complexity the individual profit-making unit; and it brings the profit-seeking manager closer to actual operations. Not quite so obvious are the incentive to economize in the use of assets and the stimulus to seek additional sources of revenue.

Third, a control system must look to the future. The heart of such a system is forecasting—the projection of business plans and alternatives into the future. Study of the past is useful, but analysis and evaluation of the results of actions *before* they are taken provide the real foundations for wise decisions.

A final condition for the effective operation of the system is a highly competent staff to develop and operate it. Though the leadership and authority for decisions must come from top management, the president obviously cannot deal with the many day-to-day problems arising in profit-center accounting and forecasting. He must look to his staff in such matters—probably to his controller.

While the technical work of planning and control may be done in a separate staff office, there are important advantages in combining it with the controller's other functions. Many of the forecasts are projections of accounting data. Moreover, the unificaton of accounting, financial analysis, and related controls in one office at the central staff level can be paralleled by a corresponding combination in the divisions. This simplifies the functional relations between staff and divisions—relations which are none too easy to maintain on a mutually satisfactory basis.

The key technician in a system of controls—the controller—has a demanding and difficult job. Some of his problems are technical and hard to solve, and the sheer volume of them is likely to overwhelm most men. Moreover, understanding of people, fairness, and integrity are just as necessary for the controller and his staff as technical ability, capacity and drive.

In closing, it might be well to summarize the reasons for establishing a system of controls in the first place: (1) Most people work harder and better if they have definite goals which have been accepted by all concerned. (2) Since the goals, i.e., the standards or budgets, are regularly re-examined, there is constant search for means to raise standards and improve performance. (3) Detailed planning and integration of various

activities lead to a better coordinated operation. (4) Since the results of programs and decisions are forecasted, it is possible to catch many mistakes before they are made and to take steps to remedy situations that promise to be unsatisfactory. (5) Though a system of controls requires the active participation of top management, it makes possible greater delegation of authority and responsibility and less routine supervision. Thus, more top management time is freed for constructive action. (6) A proper system of controls focuses the efforts of management on making profits. Many executives, I suspect, are not quite as interested in making a dollar for the business as in making a dollar for themselves—especially an after-tax dollar. This dilution of the profit motive results from taxation, from the separation of ownership and management, and from division of work and specialization. Though this situation can be remedied in part by profit bonuses and stock options, these will not control the natural propensities toward bigger and better things in each special phase of the business. Yet the biggest advertising campaigns, the newest factories, the most advanced industrial relations, and the most comprehensive system of records and reports will not add up to the most profits for the company. These special interests can be held in balance only by careful budget reviews, by decentralizing activities to profit centers as far as is practicable, and by constant pressures from profit-responsible executives who ultimately have to pay the bill.

40. MEASURING ORGANIZATIONAL PERFORMANCE

Rensis Likert*

The author claims that sole preoccupation with the traditional measurements of performance premised on such short-range end results as production, sales, and profits, overlooks and may in fact help to destroy organizational loyalty, motivation, confidence and trust which are essential to long-range performance improvement. This requires the addition of new measures of performance.

Does top management's emphasis on immediate earnings, production cost reduction, and similar measures of end results encourage division managers to dissipate the organization's human assets?

What measurable changes occur in the productivity, loyalty, attitudes, and satisfactions of an organization where decision levels are pushed down

* From *Harvard Business Review*, XXXVI, 2 (1958), 41-50. Reprinted by permission of the *Harvard Business Review*.

and group methods of leadership are employed? What measurable changes occur in an organization where decision levels are pushed upward and close control is exercised at the top? How do the results of each type of management compare in the short and long run?

What qualities of an organization can and should be measured for the purposes of appraising the leadership of division managers and others to whom authority is delegated?

Decentralization and delegation are powerful concepts based on sound theory. But there is evidence that, as now utilized, they have a serious vulnerability which can be costly. This vulnerability arises from the measurements being used to evaluate and reward the performance of those given authority over decentralized operations.

This situation is becoming worse. While companies have during the past decade made greater use of work measurements and measurements of end results in evaluating managers, and also greater use of incentive pay in rewarding them, only a few managements have regularly used measurements that deal directly with the human assets of the organization—for example, measurements of loyalty, motivation, confidence, and trust. As a consequence, many companies today are encouraging managers of departments and divisions to dissipate valuable human assets of the organization. In fact, they are rewarding these managers well for doing so!

NEW MEASURES NEEDED

The advocates of decentralization recognize that measurements play a particularly important function. Ralph J. Cordiner, one of the most articulate spokesmen, has stated his views on the question as follows:

> Like many other companies, General Electric has long felt a need for more exact measurements and standards of performance, not only to evaluate past results, but to provide a more accurate means for planning future activities and calculating business risks. The traditional measures of profits such as return on investment, turnover, and percentage of net earnings to sales provide useful information. But they are hopelessly inadequate as measures to guide the manager's effectiveness in planning for the future of the business—the area where his decisions have the most important effects.
>
> When General Electric undertook the thorough decentralization . . . , the need for more realistic and balanced measurements became visibly more acute. For with the decentralization of operating responsibility and authority to more than a hundred local managerial teams, there was a need for common means of measuring these diverse business operations as to their short-range and long-range effectiveness. . . .
>
> It was felt that, if a system of simple, common measurements could be devised, they would have these important values. . . .
>
> 1. Common measurements would provide all the managers of each component, and the individual contributors in the component, with means to

measure and plan their own performance, so that their individual decisions could be made on the basis of knowledge and informed judgment.

2. Common measurements would provide each manager with a way of detecting deviations from established standards in time to do something about it—the feedback idea, in which current operations themselves provide a means of continuous adjustment of the operation.

3. Common measurements would provide a means of appraisal, selection, and compensation of men on the basis of objective performance rather than personality judgments, which is better for both the individual and the company.

4. Common measurements would provide an important motivation for better performance, since they make clear on what basis the individual is to be measured and give him a way of measuring his own effectiveness.

5. Common measurements would simplify communications by providing common concepts and common language with which to think and talk about the business, especially in its quantitative aspects.

You will notice that all these points are directed at helping each decentralized manager and individual contributor measure and guide his own work, through self-discipine; they are not designed as a way for others to "second-guess" the manager of a component or the workers in his component.

When measurements are designed primarily for the "boss" rather than for the man himself, they tend to lose their objectivity and frequently become instruments of deception.

An adequate system of common measurements, moreover, would have the additional advantage of providing the company's executives with a way of evaluating performance in some hundred different businesses without becoming involved in the operational details of each of them.[1]

TRADITIONAL THEORY

These specifications point to serious inadequacies in the measurements now being obtained. Virtually all companies regularly secure measurements which deal with such end results as production, sales, profits, and percentage of net earnings to sales. The accounting procedures of most companies also reflect fairly well the level of inventories, the investment in plant and equipment, and the condition of plant and equipment.

But much less attention is given to what might be called "intervening factors," which significantly influence the end results just mentioned. These factors include such qualities of the human organization that staffs the plant as its loyalty, skills, motivations, and capacity for effective interaction, communication, and decision making. At present there is not one company, to my knowledge, that regularly obtains measurements which adequately and accurately reflect the quality and capacity of its human organization. (But in two companies experimental programs are underway to develop measurements of this kind.)

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[1] Ralph J. Cordiner, *New Frontiers for Professional Managers* (New York, McGraw-Hill Book Company, Inc., 1956), pp. 95-98; this volume comprises the McKinsey Lectures, which Mr. Cordiner delivered in 1956 at the Graduate School of Business, Columbia University.

There are two principal reasons for this situation: (1) The traditional theory of management, which dominates current concepts as to what should be measured, largely ignores motivational and other human behavior variables. (2) Until recently the social sciences were not developed enough to provide methods for measuring the quality of the human organization.

The traditional theory of management is based on scientific management, cost accounting and related developments, and general administrative concepts taken from military organizational theory. As a consequence, it calls for measurements that are concerned with such end result variables as profits and costs, or with such process variables as productivity.

Substantial research findings show, however, that the managers in business and government who are getting the best results are systematically deviating from this traditional theory in the operating procedures which they use. The general pattern of these deviations is to give much more attention to motivation than the traditional theory calls for. High-producing managers are not neglecting such tools and resources provided by scientific management as cost accounting; quite to the contrary, they use them fully. But they use these quantitative tools in special ways—ways that achieve significantly higher motivation than is obtained by those managers who adhere strictly to the methods specified by the traditional theory of management.

MODIFIED THEORY

The exact principles and practices of high-producing managers have been integrated into a modified theory of management, which has been discussed elsewhere. What I am interested in discussing here are the implications of this modified theory for control. Management needs to make extensive changes in the measurements now being obtained. It should take into account such factors as the levels of confidence and trust, motivation, and loyalty, and the capacity of the organization to communicate fully, to interact effectively, and to achieve sound decisions.

It is important for all companies to obtain these new kinds of measurements to guide their operations, but it is especially important for companies making extensive use of decentralization to do so. The logic of decentralization and the underlying theory on which it is based point to the need for this. In the absence of the new measurements, as we shall see presently, many managers are enabled and may even be encouraged to behave in ways which violate the logic of decentralization and which run contrary to the best interests of their companies.

It is easy to see why. Managers, like all human beings, guide their behavior by the information available to them. The measurements which a company provides them as a basis for decision making are particularly

important. They are used by top management not only to judge the performance of departmental and division heads but also, through promotions, bonus compensation, and similar devices, to reward them. If the measurements which companies use for these purposes ignore the quality of the human organization and deal primarily with earnings, production, costs, and similar end results, managers will be encouraged to make a favorable showing on those factors alone.

MANAGEMENT AND PRODUCTIVITY

Let us examine the evidence for these statements. A central concept of the modified theory is (1) that the pattern of interaction between the manager and those with whom he deals should always be such that the individuals involved will feel that the manager is dealing with them in a supportive rather than a threatening manner. A related concept is (2) that management will make full use of the potential capacities of its human resources only when each person in an organization is a member of a well-knit and effectively functioning work group with high interaction skills and performance goals.

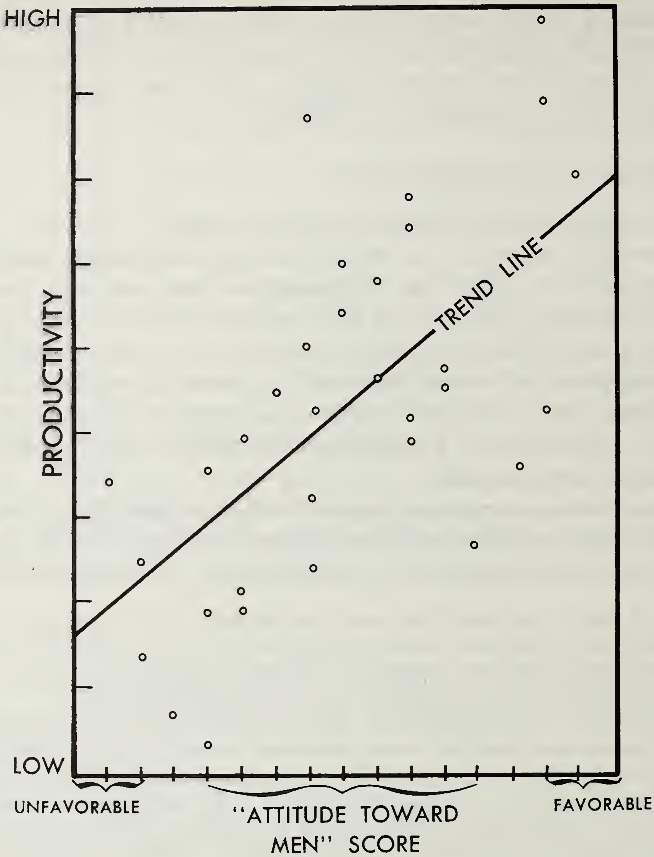
A test of these concepts, and thereby of the modified theory, was made recently using attitudinal and motivational data collected in 1955 in a study done by the Institute for Social Research, University of Michigan:

> Data are from a company that operates nationally. The company comprises 32 geographically separated units, varying in size from about 15 to over 50 employees, which perform essentially the same operations, and for which extensive productivity and cost figures are available continuously.
>
> A single score was computed for the manager in charge of each of the 32 units. These scores, based on seven questions in the managers' questionnaire, measure the manager's attitude on the two concepts which represent the modified theory. These two concepts were found to be highly related, and consequently have been handled in the analysis as a single combined score—labeled, for convenient reference, *attitude toward men.* The results obtained are shown in EXHIBIT I.

This study demonstrates clearly that those managers who, as revealed in their questionnaires, have a favorable *attitude toward men* score achieve significantly higher performance than those managers who have an unfavorable score. Managers who have a supportive attitude toward their men and endeavor to build them into well-knit teams obtain appreciably higher productivity than managers who have a threatening attitude and rely more on man-to-man patterns of supervision. (The correlation coefficient is 0.64.)

Information obtained from the nonsupervisory employees under these managers confirms the supervisory pattern reported by the managers. The material from the employees also confirms the character of the important intervening human variables contributing to the better productivity of

EXHIBIT I. RELATIONSHIP OF "ATTITUDE TOWARD MEN" SCORE OF MANAGER TO UNIT'S PRODUCTIVITY



the high-performance units. The men in those units in which the manager has an above-average *attitude toward men* score differ in their descriptions of their supervision and experience from the men in units whose managers are below average in their *attitude toward men* score. More specifically, the men in units whose managers had a favorable *attitude toward men* score are more likely than the men in the other units to indicate that:

1. The supervision of their unit is of a supportive character. This involves such supervisory behavior as being more interested in the men, friendlier, more willing to go to bat for them, and being less threatening, less punitive, less critical, and less strict (but still having high performance expectations).
2. There is more team spirit, group loyalty, and teamwork among the men and between the men and management.

3. The men have more confidence and trust in management and have higher motivation. Moreover, there is better communication between the men and management.
4. The men work under less sense of pressure, feel much freer to set their own work pace, and yet produce more.

The findings from this study are consistent with the results obtained in a number of other studies in widely different industries.[2] These other studies have also yielded evidence showing important differences in the way the managers of high- and low-producing units conceive of their job and deal with their subordinates:

The units achieving the best performance are much more likely than the poor performance units to have managers who deal with their subordinates in a supportive manner and build high group loyalty and teamwork.

The poor performance units are much more likely than the best units to have managers who press for production and treat their subordinates as "cogs in a machine."

The supportive managers tend to supervise by establishing goals and objectives for their subordinates; in contrast, the pressure-oriented managers tend to focus on the processes they want their employees to carry out in order to achieve the objectives of the manager.

DANGERS OF PRESSURE

These research findings, therefore, provide a pattern of results which confirms central concepts of the modified theory of management. These results demonstrate that, on the average, *pressure-oriented, threatening, punitive management yields lower productivity, higher costs, increased absence and less employee satisfaction than supportive, employee-centered management which uses group methods of supervision coupled with high-performance expectations.*

Since the supportive pattern of supervision tends to yield the best results, clearly this is the pattern which boards of directors and top company officials should foster in all situations including those that involve decentralization and delegation. Company officers believe, no doubt, that they are achieving this pattern of management in their operations. But, unfortunately, the performance measurements now being used by most top managements put pressures on lower levels of management to behave otherwise.

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[2] R. Kahn, "The Prediction of Productivity," *Journal of Social Issues,* Vol. 12, No. 2, 1956, p. 41; D. Katz, N. Maccoby, G. Gurin, and L. G. Floor, "Productivity, Supervision and Morale among Railroad Workers," *SRC Monograph Series No. 5* (Ann Arbor, Institute for Social Research, 1951); D. Katz, N. Maccoby, and N. Morse, "Productivity, Supervision and Morale in an Office Situation," *SRC Monograph Series No. 2* (Ann Arbor, Institute for Social Research, 1950); and R. Likert, "Motivation: The Core of Management," *Personnel Series A155* (New York, American Management Association, 1953), pp. 3-21.

What often confuses the situation is that pressure-oriented, threatening supervision can achieve impressive *short-run* results, particularly when coupled with high technical competence. There is clear-cut evidence that for a period of at least one year supervision which increases the direct pressure for productivity can achieve significant increases in production. However, such increases are obtained only at a substantial and serious cost to the organization.

TESTING PERFORMANCE

To what extent can a manager make an impressive earnings record over a short-run period of one to three years by exploiting the company's investment in the human organization in his plant or department? To what extent will the quality of his organization suffer if he does so?

CONTRASTING PROGRAMS

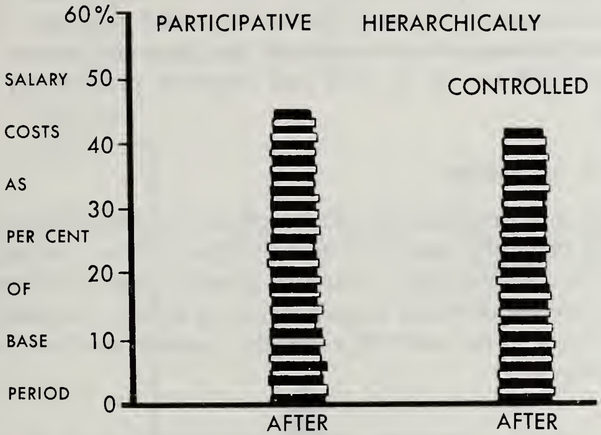
On this further question, we also have some concrete evidence from an important study conducted by the Institute for Social Research in a large multidivision corporation:

> The study covered 500 clerical employees in four parallel divisions. Each division was organized in the same way, used the same technology, did exactly the same kind of work, and had employees of comparable aptitudes.
>
> Productivity in all four of the divisions depended on the number of clerks involved. The work was something like a billing operation; there was just so much of it, but it had to be processed as it came along. Consequently, the only way in which productivity could be increased under the existing organization was to change the size of the work group.
>
> The four divisions were assigned to two experimental programs on a random basis. Each program was assigned at random a division that had been historically high in productivity and a division that had been below average in productivity. No attempt was made to place a division in that program which would best fit its habitual methods of supervision used by the manager, assistant managers, supervisors, and assistant supervisors.
>
> The experiment at the clerical level lasted for one year. Beforehand, several months were devoted to planning, and there was also a training period of approximately six months. Productivity was measured continuously and computed weekly throughout the year. Employee and supervisory attitudes and related variables were measured just before and after the period.
>
> Turning now to the heart of the study, in two divisions an attempt was made to change the supervision so that the decision levels were pushed *down*. More *general* supervision of the clerks and their supervisors was introduced. In addition, the managers, assistant managers, supervisors, and assistant supervisors of these two divisions were trained in group methods of leadership, which they endeavored to use as much as their skill would permit during the experimental year. (To this end we made liberal use of

methods developed by the National Training Laboratory in Group Development.) For easy reference, the experimental changes in these two divisions will be labeled the "participative program."

In the other two divisions, by contrast, the program called for modifying the supervision so as to increase the closeness of supervision and move the decision levels *upward.* This will be labeled the "hierarchically controlled program." These changes were accomplished by a further extension of the scientific management approach. For example, one of the major changes made was to have the jobs timed by the methods department and to have standard times computed. This showed that these divisions were overstaffed by about 30%. The general manager then ordered the managers of these two divisions to cut staff by 25%. This was to be done by transfers without replacing the persons who left; no one was to be dismissed.

EXHIBIT II. CHANGES IN PRODUCTIVITY



As a check on how effectively these policies were carried out, measurements were obtained for each division as to where decisions were made. One set of these measurements was obtained before the experimental year started, and the second set was obtained after the completion of the year. The attempts to change the level at which decisions were made were successful enough to develop measurable differences. In the hierarchically controlled program a significant shift upward occurred; by contrast, a significant shift downward occurred in the levels at which decisions were made in the participative program. Also, in the participative program there was an increase in the use of participation and in the extent to which employees were involved in decisions affecting them.

CHANGES IN PRODUCTIVITY

EXHIBIT II shows the changes in salary costs per unit of work, which reflect the changes in productivity that occurred in the divisions. As will

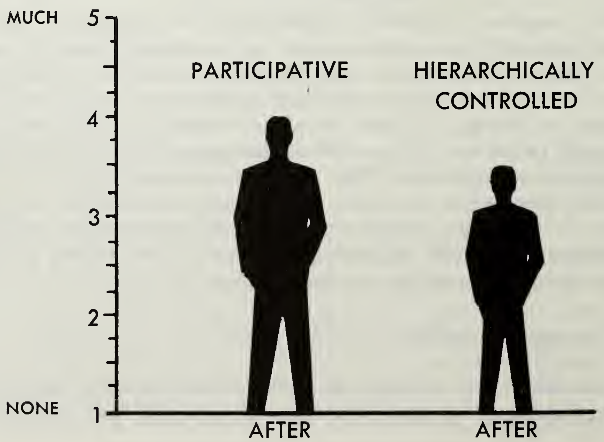
be observed, the hierarchically controlled program increased productivity by about 25%. This was a result of the direct orders from the general manager to reduce staff by that amount. Direct pressure produced a substantial increase in production.

A significant increase in productivity of 20% was also achieved in the participative program, but this was not so great an increase as in the hierarchically controlled program. To bring about this improvement, the clerks themselves participated in the decision to reduce the size of the work group. (They were aware, of course, that productivity increases were sought by management in making these experiments.) Obviously, deciding to reduce the size of a work group by eliminating some of its members is probably one of the most difficult decisions for a work group to make. Yet the clerks made it. In fact, one division in the participative program increased its productivity by about the same amount as each of the two divisions in the hierarchically controlled program. The other participative division, which historically had been the poorest of all of the divisions, did not do so well and increased productivity by only about 15%.

CHANGES IN ATTITUDES

Although both programs had similar effects on productivity, they had significantly different results in other respects. The productivity increases in the hierarchically controlled program were accompanied by shifts in an *adverse* direction in such factors as loyalty, attitudes, interest, and involvement in the work. But just the opposite was true in the participative program.

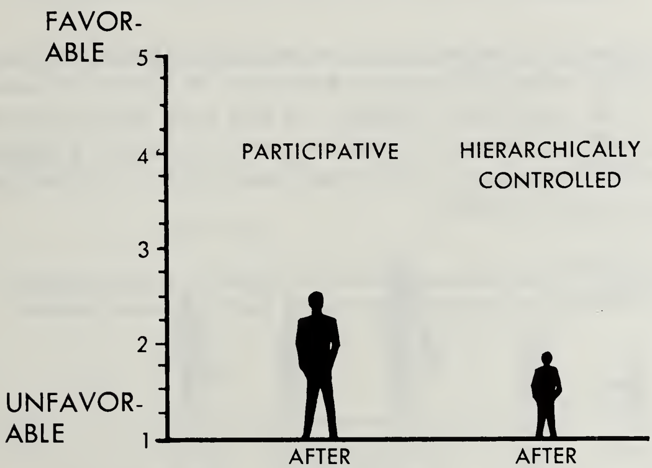
EXHIBIT III. EMPLOYEES' FEELING OF RESPONSIBILITY TO SEE THAT WORK GETS DONE



For example, EXHIBIT III shows that when more general supervision and increased participation were provided, the employees' feeling of responsibility to see that the work got done increased. Again, when the supervisor was away, they kept on working. In the hierarchically controlled program, however, the feeling of responsibility decreased, and when the supervisor was absent, the work tended to stop.

Another measurement of the extent to which an employee feels involved in his work is his attitude toward workers who are high producers. The changes in attitudes toward the high producer by the employees in the two programs are shown in EXHIBIT IV. Here again there was a statistically significant shift in opposite directions. In the participative program the attitudes became more favorable, and there was less pressure to restrict production. In the hierarchically controlled program the opposite effect occurred.

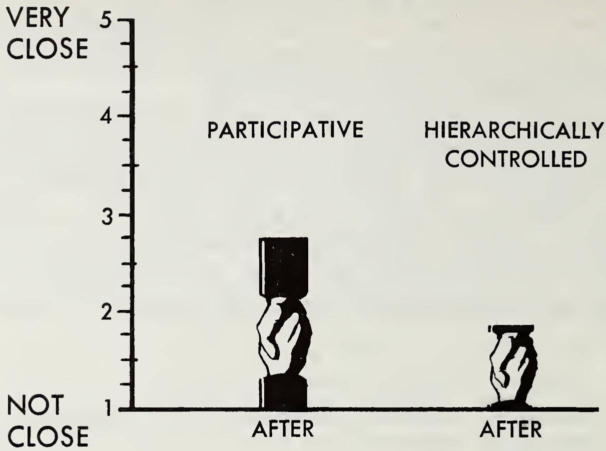
EXHIBIT IV. EMPLOYEE ATTITUDES TOWARD HIGH PRODUCER



In industrial organizations that are effective in achieving their objectives, extensive research in a variety of organizations shows that superiors and subordinates are linked by loyalty, a mutual feeling of understanding and closeness, and a feeling that influence and communication (both upward and downward) function well. How are these attitudes and feelings achieved? Our study of the four divisions throws some light on the answer.

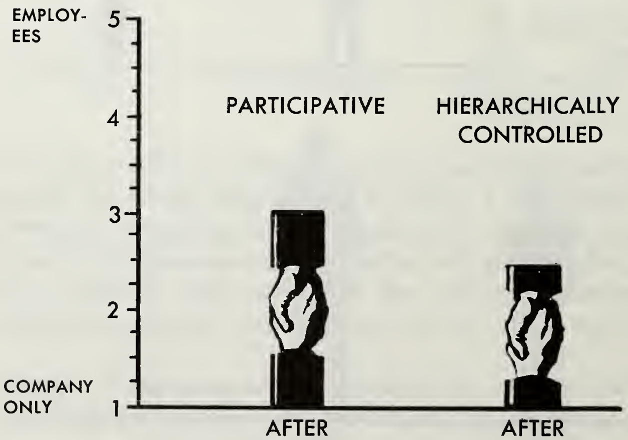
As EXHIBIT V shows, the employees in the participative program at the end of the year felt that their manager and assistant manager were "closer

EXHIBIT V. HOW CLOSE MANAGER AND ASSISTANT MANAGER WERE FELT TO BE TO EMPLOYEES



to them" than at the beginning of the year. The opposite was true in the hierarchically controlled program. Moreover, as EXHIBIT VI shows, employees in the participative program felt that their superiors were more likely to "pull" for them, or for the company *and* them, and not be solely interested in the company; while in the hierarchically controlled program, the opposite trend occurred.

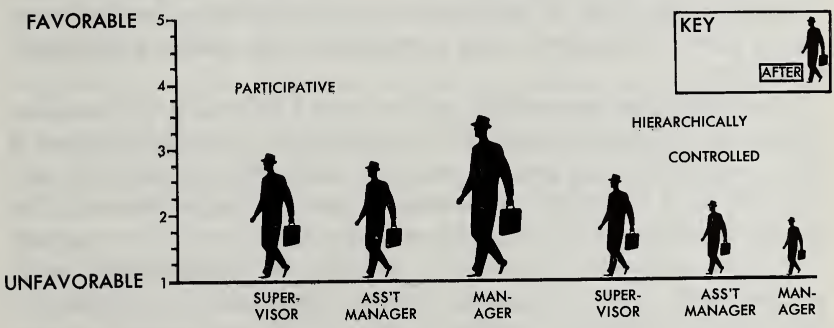
EXHIBIT VI. EMPLOYEE OPINIONS AS TO EXTENT TO WHICH SUPERIORS "PULLED" FOR COMPANY ONLY OR FOR EMPLOYEES AND COMPANY



As might be expected from these trends, a marked shift in opposite directions showed up during the year in the employees' feeling of satisfaction with their superiors. EXHIBIT VII shows the shifts in employees' feelings as to how well their superiors communicated upward and influenced management on matters which concerned them. Once again the participative program showed up better than the hierarchically controlled program. One significant aspect of the changes in attitude in the hierarchically controlled program was that the employees felt that their superiors were relying more at the end of the year on rank and authority to get the work done than was the case at the beginning of the year. "Pulling rank" tends to become self-defeating in the long run because of the hostilities and counterpressures it evokes.

The deterioration under the hierarchically controlled program showed up in several other ways. For instance, turnover increased. Employees began to quit because of what they felt to be excessive pressure for production. As a consequence, the company felt it desirable to lessen the pressure. This happened toward the end of the experimental year.

EXHIBIT VII. EMPLOYEE'S SATISFACTION WITH SUPERVISORS AS REPRESENTATIVES



Unfortunately, it was not possible to conduct the participative and hierarchically controlled programs for more than one year because of changes in the over-all operations of the company. However, the significant trends in opposite directions which occurred in these two programs are the trends which would be expected in the light of the studies cited earlier in the article. The attitudes which improved the most in the participative program and deteriorated the most in the hierarchically controlled program are those which these studies have consistently shown to

be most closely related *in the long run* to employee motivation and productivity. This gives us every reason to believe that had the clerical experiment been continued for another year or two, productivity and quality of work would have continued to increase in the participative program, while in the hierarchically controlled program productivity and quality of work would have declined.

IMPLICATIONS FOR POLICY

What are the implications of all this for management policy—particularly in the company that is decentralizing its operations or otherwise delegating a good deal of authority to various managers?

TREATMENT OF HUMAN ASSETS

To begin with, most executives will readily agree that it costs money to hire and train personnel. And, after personnel have been hired and trained, it takes additional time and money to build them into a loyal, well-knit, effectively functioning organization with well-established goals. Most businessmen will also agree with the research findings which show that the more supportive the supervision and the better the organization (in terms of loyalty, level of performance goals, communication, motivation, and so forth), the greater is its capacity for high-quality performance at low cost.

If we make these assumptions, we can come, I believe, to only one conclusion. As was demonstrated in the hierarchically controlled program of the experiment, putting pressure on a well-established organization to produce can yield substantial and immediate increases in productivity. *This increase is obtained, however, at a cost to the human assets of the organization.* In the company we studied, for example, the cost was clear: hostilities increased, there was greater reliance upon authority, loyalties declined, and motivations to produce decreased while motivations to restrict production increased. In other words, the quality of the human organization deteriorated as a functioning social system.

If the company had had an accounting procedure which showed the investment in the human organization, it would have shown that in the two divisions in the hierarchically controlled program the value of the human organization was less at the end of the experimental year than at the beginning. In other words, some of the increased productivity was achieved actually by liquidating part of the investment which the company had in the human organization in these divisions. The increase in productivity should have been charged with this cost.

On the other hand, had the company's accounting records reflected the value of the company's investment in the human organization in the two divisions in the participative program, they would have shown an opposite picture. During the year, the value of this investment increased. The management of the two divisions had been of such a character as to increase the productive capacity of the organization as a functioning social system: loyalties had increased, hostilities had decreased, communication was improved, decisions were better since they were based on more accurate and adequate information, and production goals and motivations to produce were increasing.

While a company's investment in its human organization is less tangible than the investment in plant and equipment, and therefore has not yet been given the kind of evaluation an accountant would give it, *it can be measured approximately with the methods now available.* These methods can enable management to size up present trends, analyze their relationships, and guide company operations accordingly.

QUANTITATIVE CONTROLS

Companies are very careful not to let managers of decentralized plants show spurious profits and earnings by juggling inventory or by failing to maintain plant and equipment. Their accounting procedures measure and report regularly on inventory and condition of plant and equipment. "Earnings" achieved by liquidating the assets represented in the human organization are just as spurious as though achieved by liquidating the investment in plant. Yet they are encouraged by compensation formulas that urge managers to press unduly for immediate production, cost reduction, and similar goals; by the present-day emphasis on measuring only the end results of the activities of the lower echelons or of decentralized operations; and by job evaluations focused on the immediate contribution to earnings and profits.

In the long run, of course, such measurements are valid. The executive who "milks the human franchise" today will not be in a position to show good profit-and-loss figures tomorrow. The catch is that, by the time the symptoms of trouble are clear, the human organization has deteriorated to a point where steps to correct it are difficult and costly. As a practical matter, moreover, there is often so much rotation in executive responsibilities, and so much change in the conditions of business, that short-run tests which will provide adequate measures of current performance, including trends in the human organization, are worth much more than long-run evaluations.

There is only one solution to this problem, and it does not yet lie in more precise accounting data. The solution is to obtain adequate periodic

measurements of the character and the quality of the human organization. Judgment alone is notoriously inaccurate and tends to be most inaccurate in those situations which are unsatisfactory or deteriorating. Measurements and compensation formulas are needed which will penalize managers financially and otherwise when they permit the quality of the human organization under them to deteriorate, and reward them when they improve the quality of this organization.

Identically the same point can be made with regard to consumer attitudes, good will, and confidence in the company, in its products, and in its service. A manager of a decentralized operation can substantially increase current earnings by reducing the product quality with low-cost, shoddy output. However, the immediate earnings shown on the company books would be spurious and would actually represent a substantial liquidation of the investment made in developing consumer confidence and accceptance. Therefore, periodic measurements of consumer perceptions, attitudes, and acceptance should be made not only for the usual purposes, such as to provide direction in product development and to guide advertising and marketing, but also to protect the company's investment in consumer good will.

ADEQUATE APPRAISALS

It is not sufficient merely to measure morale and the attitudes of employees toward the organization, their supervision, and their work. Favorable attitudes and excellent morale do not necessarily assure high motivation, high performance, and an effective human organization. A good deal of research indicates that this relationship is much too simple. Favorable attitudes may be found, for example, in situations where there is complacency and general contentment but where production goals are low and there is little motivation to achieve high performance.

Similarly, measurements of behavior which reflect the past condition of the human organization, while useful, are also inadequate for current appraisals. Such measurements as absence, turnover, and scrap loss tend not only to be insensitive measurements but also to reflect changes in the human organization *after* they have become substantial. More sensitive and more current measurements than those are needed.

Progress in the social sciences in recent years enables any company which so desires to obtain measurements needed for adequate appraisals of the quality and performance capacity of its human organization. Instruments to measure many of the important variables are now available; for those variables for which measuring instruments are not now available, the basic methodology now exists to develop the necessary tools. The organization for which these measurements are obtained can be an entire corporation or any of its divisions.

The following illustrate the kinds of variables which are now being measured in some companies or for which satisfactory measuring instruments can be developed:

1. Extent of loyalty to and identification with the institution and its objectives.
2. Extent to which members of the organization at all hierarchical levels feel that the organization's goals are consistent with their own needs and goals, and that the achievement of the company's goals will help them achieve their own.
3. Extent to which the goals of units and of individuals are of a character to enable the organization to achieve its objectives.
4. Level of motivation among members of the organization with regard to such variables as:
    a. Performance, including both quality and quantity of work done;
    b. Concern for elimination of waste and reduction of costs;
    c. Concern for improving product;
    d. Concern for improving processes.
5. Degree of confidence and trust among members of the organization in each other and in the different hierarchical levels.
6. Amount and quality of teamwork in each unit of the organization and between units.
7. Extent to which people feel delegation is being effectively achieved.
8. Extent to which members feel that their ideas, information, knowledge of processes, and experience are being used in the decision-making processes of the organization.
9. Level of competence and skill of different groups in the organization to interact effectively in solving problems and other tasks.
10. Efficiency and adequacy of the communication process upward, downward, sidewise.
11. Level of the leadership skills and abilities of supervisors and managers, including their basic philosophy of management and orientation toward the processes of leadership.
12. Aptitude scores of the members of the organization. If aptitude scores are obtained as people join the organization, then trends in these scores will show whether the current management is improving the basic quality of the personnel through its hiring practices or is letting quality deteriorate through unfavorable turnover.

JOB FOR EXPERTS

The measurement of these variables is a complex process and requires a high level of scientific competence. It cannot be done by an untrained person, no matter how intelligent he is. Nor can it be done simply by asking people questions that have not been pretested or by handing them a ready-made questionnaire. Few companies trust cost figures obtained by inexperienced personnel. It is equally dangerous to trust the untrained to obtain measurements of the state of a human organization.

CONCLUSION

Industry needs more adequate measures of organizational performance than it is now getting. Progress in the social sciences now makes these measurements possible. As a consequence, new resources are available to assist company presidents in their responsibility for the successful management of their companies.

The president's responsibility requires that he build an organization whose structure, goals, levels of loyalty, motivation, interaction skills, and competence are such that the organization achieves its objectives effectively. As tools to assist him and the other members of management, a president needs a constant flow of measurements reporting on the state of the organization and the performance being achieved. The measurements proposed here would provide a president with data which he needs to fill the current serious gap in the information coming to him and to his organization.

PART TWO

EXECUTIVE ACTION

Section C:

METHODS AND PROCEDURES OF EXECUTIVE ACTION

It is intended that this section of the book of readings be regarded as a practical application of selected portions of the subject matter of administration and its major functions of planning and control. Even though it is the intent to approach the topics covered from the point of view of top and middle management, various elements of such tool subjects as accounting, marketing, finance, economics, statistics and other skills, methods, and procedures which may be regarded as to-be-delegated staff functions, are included to give a comprehensive over-view of the various factors and steps involved. The successful and efficient discovery, evaluation, and ranking of alternative propositions, which is essential to good planning, requires a rather intensive use of staff functions and personnel. None of the "tools" should be arbitrarily rejected.

The budgetary process oftentimes is used in over-all planning as a coordinating device, and even in the event that a budget is not prepared and formally adopted any comprehensive planning of future action should utilize many if not all of the steps of the customary budgetary process. Planning of course occurs at various levels of the organization and varies considerably in importance as do the decisions

which are expected to result from planning. Presumably time and resources devoted to a particular planning effort should bear a reasonable relationship to the importance of the decision: so also should the subsequent control of the selected plan.

In comprehensive planning many interrelationships must be taken into account and coordinated in a meaningful manner. Difficulty in deciding what should come first therefore is always a problem when ranking the topics, and no completely satisfactory solution seems possible, even with "good planning."

Planning and budgeting appear to be, from one point of view at least, the major or general topic. James D. Willson outlines budgeting, and in another article discusses cost-volume-profit analysis which, incidentally is also covered in other chapters and sections as profitgraphs and break-even analysis. J. Fred Weston and Edward W. Binshadler point up the importance of the financial side of the business operations and discuss forecasting, planning and control aspects of finance.

Capital budgeting, concerned as it is with long-range problems primarily, is dealt with in a separate chapter. An article from *Business Week* of September 27, 1958, describes in fairly general terms the use of the two most widely recognized methods of deciding when to replace depreciable fixed assets by means of discounted flow techniques. Philip A. Scheuble, Jr., discusses the subject in a related manner. Ezra Solomon discusses some general as well as perplexing factors in reaching capital budgeting decisions. The article from the *ACME Reporter* is a fairly useful summary of the over-all problem of capital budgeting and the steps involved as well as the factors to be taken into account. Capital budgets, although seemingly separated from operating budgets, because of their long-range characteristics, nevertheless must be fitted into the budgets for specific periods, if for no other reason than that they must be put into effect during some specific period as well as having a continuous effect when they are adopted and made operative.

Another overriding consideration which must be taken into account both prior to and during the budget period is the matter of pricing policy. An important article on multistage pricing opens the chapter devoted to pricing policy. Walter B. McFarland describes the results of a survey re-

lated to standard cost which has some bearing on pricing. Other articles in the chapter take up various elements and considerations involved in pricing both from an internal use as well as from an external point of view. The relationship of cost and price, a familiar one, is complicated by the oftentimes large number of factors which a specific business enterprise must take into account in setting price: seldom is a company able to set prices based solely on consideration of its own interests and its own state of affairs. A large variety of short- and long-range competitive and investment factors, often conflicting with each other as well as consumer reactions to price change, must be taken into account regardless of cost considerations. Instead of pricing policy the matter may also be described as pricing strategy.

The matter of controlling profitability, which has been assigned the status of a separate chapter, probably is more allied with or dependent upon a careful application of planning and control through such familiar devices as organization, budgets, standard cost, and comparative reports. The chapter should not be regarded therefore as a comprehensive coverage of the topic, for to do so would involve undesirable duplication with selections in other chapters and sections. Leland G. Spencer's article on "The Profitgraph—Technique and Applications" quite clearly involves cost-volume-profit and break-even considerations. Joel Dean's article "Measuring the Productivity of Capital" has general applicability to capital budgeting as well as to the evaluation of various decisions mostly of a long-range nature. Gordon Shillinglaw's "Guides to Internal Profit Measurement" gives a thorough going method of analysis to aid in measuring and evaluating departmental and other internal profit contributions toward the common goal. Joel Dean in an article pertaining to the same subject emphasizes the advantages of a carefully planned program of decentralization and transfer pricing.

XI

CAPITAL BUDGETING—CONTROLLING PLANT EXPENDITURES

41. HOW TO FIGURE EQUIPMENT REPLACEMENT

Philip A. Scheuble, Jr.*

The author discusses practically all (if not all) factors which enter into and influence equipment replacement decisions. Many of the methods of evaluating future estimates as well as present and past cost data are included in the article.

It has long been recognized that decisions on equipment replacement can have a profound effect on the future course of the business and its financial stability. But many managements, while closely controlling the making of such decisions at the top executive level, have no definite policy or procedure for determining if and when a replacement should take place.

A sound approach to this problem can do much to stimulate thinking about more efficient processes and equipment utilization, not only on management's part but throughout the organization. What is needed is a method of analysis that "explains" equipment decisions in terms of company objectives and working capital availability so all concerned can understand.

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* From *Harvard Business Review,* XXXIII, 5 (1955), 81-94. Reprinted by permission of the *Harvard Business Review.*

Today there is even more of a stake in basing equipment replacement decisions on accurate measurements rather than on generalities, now that the federal tax laws have been liberalized to allow larger depreciation during the early years of equipment life.

PROBLEMS INVOLVED

Equipment replacement problems have been analyzed from various viewpoints, ranging from the "one hoss shay" attitude of not replacing until the present equipment falls apart to that of replacing simply because a newer machine tool may indicate an apparent operating cost saving over the one in use. But these diverse views are not answers in themselves; they are only symptomatic of the problems of equipment replacement.

A replacement decision usually involves much more than a consideration of comparative annual operating costs and wear. There is the problem of determining the most advantageous use of available capital funds and making sure that a desired return on the invested capital will be received. This problem, in turn, is inextricably bound up with making estimates of the future as to:

Whether the necessary volume will be maintained to realize the operating cost advantages of the new equipment.

Whether there are possible alternate uses of that equipment.

Whether overhaul of present equipment would be sufficient, and for how long.

Whether more advantageous equipment will appear on the horizon in the near future.

Also involved is consideration of the possible adverse effects of *not* replacing—i.e., higher operating costs, lower quality, poorer customer service, forsaking of additional volume, loss of markets, and slowing up of long-range plans.

Although these problems may appear formidable at first glance, they can be reduced to measurable quantities which will permit their evaluation.

RANGE OF SITUATIONS

The term "equipment replacement," as used here, is rather broad in its application, since it is meant to cover any situation where unit costs can be reduced or profits increased by a capital expenditure. Basically, the consideration of new plant, new equipment, or replacement of existing equipment poses the same task of economic analysis, although each represents a different degree of complexity. Even when replacements are to be made for prestige or publicity reasons with no regard for profit potential,

as sometimes happens, it is desirable to know how the contemplated project compares with other projects.

Included in the consideration of equipment replacement are many factors often thought of as intangibles. The fact is that such an item as quality can be measured quantitatively in terms of scrap cost, rework cost, inspection cost, and loss of sales volume. Other long-range considerations, while difficult to measure, can often be determined with workable accuracy by the use of cost and profit *estimates* (so long as their reasonableness is established and their lack of preciseness is taken into account in the interpretation of final results).

VARIETY OF REASONS

The degree of need for replacement varies from company to company according to sales volume, product character, competition, and so on. Thus, in a single-product, high-volume operation, on the one hand, a small decrease in unit cost may easily justify replacement. The management of a more diversified plant, on the other hand, may need to ponder longer before deciding on a replacement; here the question may be whether new equipment will give the shop more versatility, and so increase profits through greater volume rather than through decreased operating costs.

Need for replacing equipment may stem from any one or a combination of the following reasons:

1. Present equipment is not functioning properly with one or more of these results: excessive idle time, poor product quality, increased labor cost, high operating cost, abnormal maintenance expense. (Of course, overhaul may in many cases correct these conditions.)
2. There is a current or an anticipated need for expanded or diversified capacity.
3. New or improved products have been introduced for competitive or other reasons. (New products may make equipment purchases mandatory; hence they should be subjected to a prior evaluation of their effect on present equipment.)
4. More efficient equipment is available on the market, even though the present equipment may still perform satisfactorily.
5. Increased mechanization will reduce labor cost and/or increase quality.
6. Process and methods changes have been developed to reduce cost or to increase quality.
7. It is necessary to eliminate safety hazards; here the protection of workers is paramount, but there also will be gains in the form of increased operator output (due to better morale) and reduction of industrial compensation costs.
8. It is possible to achieve more efficient production or reduce indirect costs by plant rearrangement, improved materials handling, establishment of manufacturing services, and so forth.

METHOD OF ANALYSIS

A comprehensive equipment replacement decision generally requires the use of more than one evaluation factor. It cannot be based on a "yes" or "no" answer turned out by formula.

The method of analysis used must relate capital and operating cost factors over their duration, taking into consideration the desired percentage return on invested money. (This involves mathematical relationships with an element of compound interest, but a formula can be adapted to a simple and rapid solution.)

Since an equipment replacement analysis may require the use of assumptions as well as of estimates, the method must also provide a quick means of evaluating their effect in relation to the possible range of error.

Furthermore, the method should be flexible enough to aid in finding a solution, rather than place a strait jacket on the thinking of those concerned with the question. I cannot overemphasize the fact that there is no substitute for the use of good judgment at all the organizational levels involved. In other words, the measurement devices used should never be considered as criteria in themselves but only as aids in leading to a sound decision.

More specifically, the method of analysis I am proposing measures the annual cost savings or profit potential of the proposed replacement against the capital investment made, taking into consideration the desired percentage return on investment, the capital recovery period, and the service life of the equipment. This implies three basic tests which a replacement should pass before it is approved:

1. Its capital recovery period must reasonably correspond with its period of potential utilization, at the annual volume defined in the analysis.
2. Its annual savings or profit potential, after paying for its amortization and return on investment over its service life, must compete with other replacement proposals in their call on capital funds.
3. The replacement must fit in with the resources and future plans of the company.

EIGHT YARDSTICKS

As a practical matter, good judgment depends on *standards* of measurement. The essence of my approach is the use of eight yardsticks, which taken together form the basis for a sound conclusion (listed not in order of importance but as they will be discussed):

1. The operating cost savings (or increased profit potential) afforded by making the replacement.
2. The rate of return desired on the invested money.
3. The capital recovery period, and its relation to the period of equipment utilization.
4. The service life of the equipment, and its relation to deterioration and obsolescence.

5. The total money invested in the replacement.
6. The net savings over the service life of the equipment.
7. The priority of a replacement in relation to other replacements and the availability of capital funds.
8. The effect of taxes.

The application of the replacement yardsticks can best be explained by actual problems. However, it is first necessary to have a detailed understanding of the yardsticks themselves.

OPERATING COST SAVINGS

The advantage of a replacement may be in the reduction of operating costs; or, because of a capacity increase or greater equipment versatility, the enterprise may increase its dollar sales volume with possible profit improvement. Either situation increases the earnings potential of the company. But whether it is a matter of operating costs or of profit margin, the analysis must not overlook the common denominator of volume, since this factor determines the utilization of the equipment and affects unit cost and profit.

For this reason an equipment replacement analysis must be based on a reasonable estimate of the volume that will be produced by the equipment being considered for replacement. I have found many instances of relatively new equipment working at a low level of utilization because of poor volume forecasts, with the result that the annual real capital costs are greater than the savings. In such cases, it might have been more prudent to retain the older equipment until the market was more certain.

ANNUAL COST COMPARISON

The usual starting point of a replacement analysis is the determination of the annual cost savings or dollar profit improvement afforded by the new equipment, in comparison with the status quo. (If present equipment can be overhauled, the cost savings aspects of that alternative must also be determined.)

The annual cost comparison can embrace many factors, depending on the particular application. The following list covers a large number of situations:

Profit
Direct labor
Indirect labor
Fringe labor benefits
Maintenance and repair
Tools
Tool repair
Scrap and rework
Inspection costs

Setup time
Down time
Materials handling
Materials cost
Supplies
Power costs
Floor space
Taxes and insurance
Subcontract costs

The time and effort needed to get figures for all these factors may seem excessive. Yet the actual time spent is small in comparison with the capital outlay usually under consideration. The more limited a company's funds, the less it can afford a cursory review.

The operating cost factors are calculated on an annual basis and take into consideration, where applicable, the average annual volume of business that the replacement will affect. Where a replacement analysis is organized as a formal procedure in a company, the operating cost factor analysis form should include a section that analyzes the projected volume, its possible duration, and its effect in terms of the anticipated percentage utilization of the proposed equipment. Of course, judgment must play a large part in such projections. Some objections may be raised against this "crystal ball" aspect, but there is usually a way to get around it. An objective basis of comparison, however imperfect, is better than vague generalities.

While most of these factors are self-explanatory, the following warrant special emphasis:

Direct labor–Only measurable savings should be used. Elimination of a fraction of an operator should not be considered unless his time can be effectively utilized elsewhere. Some replacements may increase the equipment capacity per worker, but unless this increase is utilized, it should not be considered as a saving.

Overhead costs–Savings in overhead costs should not be calculated by applying an overhead percentage rate to the direct labor savings. Only those incremental overhead cost factors affected by the replacement should be considered.

These statements can be explained by considering a replacement that will double production, and the increase can be absorbed by the market. Labor cost in this case has been reduced by one-half. However, the annual overhead cost probably has not been reduced; in fact, it may be increased by additional inspection and other service requirements. The replacement may be a desirable one, however, because of the annual labor savings and the increase of annual dollar profit due to a larger sales volume. At this point, depreciation rates should not be considered in analyzing the operating cost factors since the effect of capital cost is considered elsewhere in the procedure.

Maintenance and repair–These costs include the day-to-day equipment maintenance and miscellaneous repair costs necessary to keep the equipment operating properly (but not major overhaul, which itself constitutes an alternative to the present situation). At this point in the analysis, we are concerned with measuring the difference between the present situation and its proposed alternative, and for practical purposes it is usually sufficient to calculate their present differential.

The proposed replacement may result in either an increase or a decrease in the various operating cost factors. Only the plus or minus differential amounts need to be considered. Their total is the "annual gross savings."

RATE OF RETURN ON INVESTMENT

As used here, rate of return on investment refers to the annual interest on the unpaid balance of invested capital. On this basis, the annual capital charge against the replacement consists of two parts: (a) the annual amortization (or reduction) of the capital invested in the equipment; (b) the annual interest on the unamortized portion of the investment.

This concept becomes more meaningful when viewed as a mortgage taken on the equipment by management. The annual payments on this mortgage are made by the equipment through its annual savings or profit increase. The interest portion of these equal annual payments is the rate of return to be realized from the investment in equipment and is a measure of the earnings potential of the proposed replacement, as compared with the investment of that money in the day-to-day operation of the business. It is a more fundamental measure than annual gross savings, since it is directly related to the investment and the time period involved.

The mathematical relationship among the annual gross savings, the investment, the desired percentage return on investment, and the period of capital recovery is expressed by an annuity (mortgage) formula, which has wide application to many problems involving the time-interest consideration of money. A *nomogram* (see EXHIBIT 1) simplifies the solution by producing an answer through the use of a straight edge. The operation of the percentage return on investment concept can be illustrated by the following example:

Without consideration of return on investment, it would take 2 years to recover a capital investment of $10,000 paid back at the rate of $5,000 per year. But if there were, say, a 20% return on investment requirement, the capital recovery period would be about 3 years.

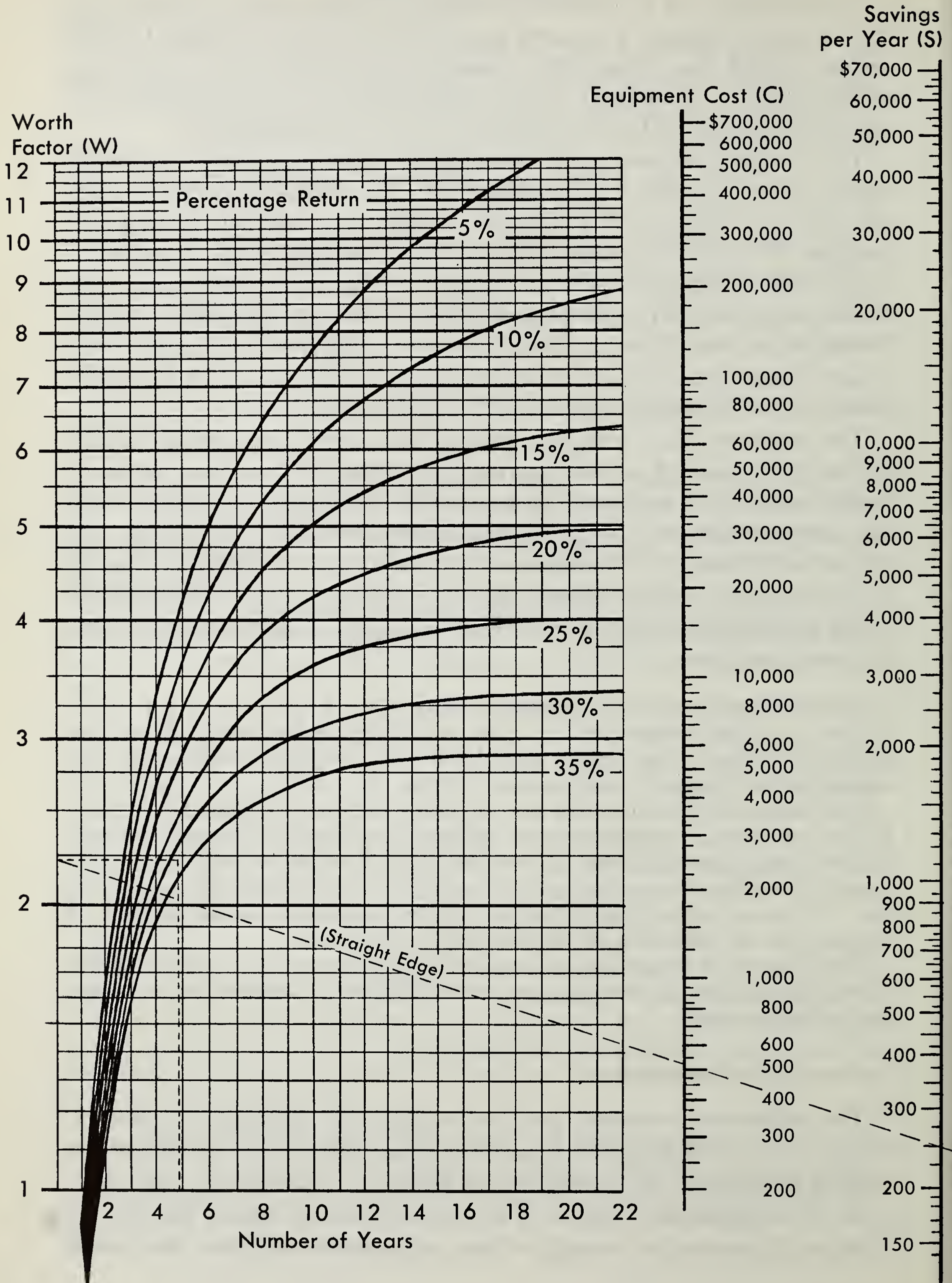
This answer is obtained on the nomogram by setting a straight edge between $10,000 on Scale *C* (equipment cost) and $5,000 on Scale *S* (savings per year). The straight edge should then be extended until it intersects Scale *W* (worth factor); from this intersection point (2 on Scale *W*), read over horizontally to the 20% return curve. Then from this point of intersection on the curve, read down to get the time-value on the base line–i.e., 2.8 years.

This process, of course, can be reversed by starting out with a given capital recovery period and working out answers for different combinations of savings and equipment cost.

MANAGEMENT VIEWPOINT

The return-on-investment goal for a particular enterprise depends on many factors, including the type of business, the rate of its return on existing investment, the availability of funds, and, particularly, the viewpoint of management in regard to the employment of capital. Because the value of the return rate strongly affects replacement decisions, this matter

EXHIBIT I. NOMOGRAM RELATING SAVINGS PER YEAR, EQUIPMENT COST, AND NUMBER OF YEARS TO PAY OFF AN INVESTMENT PLUS A GIVEN PERCENTAGE RETURN ON INVESTMENT



of management viewpoint is crucial. The possible viewpoints range between these two extremes:

> One extreme viewpoint holds that only the cost of obtaining working capital should be considered—in other words, the cost of debt or equity financing. Under this arrangement the return to the enterprise is zero, since the equipment is only required to support the cost of money.
>
> The other extreme viewpoint deliberately imposes a relatively high rate-of-return requirement, the purpose of which is to conserve the cash position of the company (especially if capital is difficult to obtain) and, in some cases, to act as a safety factor against rule-of-thumb estimating.

Such extremes must be avoided, for they are likely to distort judgment. If it is to be a reliable guide, the return rate will have to reflect factors related to the use of the capital as well as its acquisition. Further, a replacement opportunity under consideration will not be expected to return any more (or, for that matter, any less) than the going or desired rate of return applying to the employment of capital in other phases of the business. Of course the final decision on a capital expenditure should take the maintenance of the cash position into account; and of course safety factors are not necessarily inappropriate if they are introduced into the analysis at points where they can be recognized for what they are. But the return rate itself must be kept pure and sound.

Perhaps the importance of looking at the return rate in this way can be better understood when it is realized that we are measuring a given proposal against all alternatives, including other possible replacement proposals. The rate of return affects all proposals equally, and adjusts for the time-value of money. It does not attempt to dictate which replacement has first call on available capital funds.

CAPITAL RECOVERY PERIOD

A measurement of the capital recovery period is involved in the first of the three basic tests that a proposed replacement must pass. If this recovery period, which includes the return on investment, reasonably corresponds to the period of anticipated equipment utilization at the volume stated in the analysis, it is logical to assume that the desired return may be achieved. This assumption is no less valid than the usual consideration one must give to the uncertainty of the future.

At this point a distinction must be made between a replacement that is being contemplated primarily because a more efficient machine is available and one that is required because of physical deterioration of present equipment (though, obviously, many situations involve both factors). When management is confronted with a situation involving deterioration, usually

the urgency of replacement is greater, but the decision is simpler. The problem resolves itself into comparing the alternatives of overhaul versus buying; and since the need is established, it is redundant to apply the test of the capital recovery period. But the factor of utilization must be weighed, because that will determine the future need.

STANDARD GUIDEPOSTS

It is helpful to set up standard capital recovery periods to act as guideposts to the operating organization. Determination of specified return periods is a problem that each company must solve for its own situation; but, just to give a rough idea of what they might be like, a management might conceivably set up return periods of (a) *one year for tooling*, (b) *three years for production machine tools*, (c) *six years for toolroom equipment.*

Guideposts of this kind are effective as standards of performance—a coarse screening device for proposed replacements. But note that, if handled properly, this is more than a matter of eliminating unsound proposals. Where an otherwise worthwhile replacement does not quite meet the standards, the procedure requires that a closer look be taken to improve the proposed method or, if such improvement is impractical, that a further check be made on the projected volume.

Furthermore, if an organization is pursuing a vigorous program of process and equipment improvement, the use of these standard guideposts can actually encourage a search for the numerous potential replacements that may be worthwhile. Technical progress is not stifled, since a worthwhile project can clear the first hurdle—and a first hurdle is what it is, rather than a final determinant—so long as the cost savings and volume forecasts are satisfactory in terms of the time required for capital recovery.

SERVICE LIFE

The service life of equipment determines the real annual capital cost for a given investment at a given rate of return, since for replacement analysis purposes the investment is amortized over that life. It is related to the period of its usefulness to the company, and is linked with economic as well as mechanical factors.

OBSOLESCENCE AND WEAR

The belief that an asset has an inherent service life independent of the duration of its specific application is misleading. Equipment obsolescence due to the availability of more efficient machines on the market can have

a marked effect on service life, regardless of how excellent the condition of the older equipment may be; and product obsolescence will have a similar effect if there is no alternate use for the equipment involved. In other cases, however, the effect of obsolescence may be small in comparison to that of wear.

Where both obsolescence and wear are involved, as is usually the case, their effects must be evaluated separately since they usually do not occur simultaneously.

Obsolescence and wear are both measured in terms of operating costs, although their basis of measurement differs. Obsolescence cost is determined by a comparison with a replacement that is superior in operation. This cost cannot be determined until such a replacement is available on the market. Wear, on the other hand, occurs gradually through usage, and records usually provide some historical basis for a reasonably firm cost prediction.

In making a replacement decision, it is not necessary to predict the future cost effect of obsolescence on the replacement until that time actually arrives. We are, however, interested in the obsolescence of our present equipment, which has been brought about by the operating savings afforded by the proposed replacement. These savings would hold throughout the service life of the proposed replacement if wear did not take place. However, wear does occur, and the dollar amount must be predicted quantitatively in order to adjust for its effect on potential operating savings.

This viewpoint rejects the academic approach of attempting to determine an inherent service life for this replacement (and for the other challengers to it that will follow) by trying to measure as a unit both wear and future obsolescence cost. Instead, we are interested in the practical problem of comparing the projected annual savings advantage with the present cash outlay, and measuring the effect of future wear on this comparison. Over the course of successive replacements, we can be confident that we can maintain the desired return on investment if the annual gross savings figure for each replacement, adjusted for the cost of wear, exceeds its real annual capital cost.

REPAIR COSTS

Wear is a physical phenomenon, but it can be reasonably measured by repair costs. Most equipment consists essentially of a structure that supports, and also may be in contact with, moving parts. Since these parts wear, they must be replaced to maintain the original operating characteristics of the equipment. Eventually the structure will deteriorate, but generally the time span involved is comparatively long, and often such deterioration, as well as breakage, can be repaired.

The incidence and amount of repair costs are difficult to determine, but they are usually low in early life and increase with age. Since their growth pattern is indeterminate, we may for the sake of convenience assume that they increase in proportion to equipment age, without introducing any critical errors. Historical records on repair costs can often provide average values that are sufficiently accurate. However, if such information is not available from the inception of equipment use, as is often the case, an estimated average annual value can be calculated by dividing by 2 a known average value of repair costs for a given year. To illustrate:

If at the tenth year the repair cost for that year was $1,000, its average annual value over ten years is calculated to be $500.

This figure is understated in that the true mathematical average would be $550 (10 divided into the sum of $100, $200, $300, $400 . . . on up to $1,000 at the tenth year).

At the same time, there is more than enough compensating overstatement in the figure due to the fact that it fails to take into account the future time-value of money.

So, on balance, the figure is slightly overstated.

While it is difficult to generalize for all problems, this treatment of repair costs will help to offset estimates of annual gross savings that are too generous. Because exact values are difficult to predict, and the tendency is more likely to be toward not allowing enough for the cost of maintaining the equipment at top efficiency, it is more practical in this case to be conservative. In any event, disregarding major overhaul costs (which in this method of analysis are treated as an alternative capital expenditure), the possible error involved in the average predicted repair value is usually small in relation to the magnitude of other cost factors which will dictate replacement.

THE OVERHAUL POINT

Thus far we have not found the answer to determining when obsolescence or wear establishes the service life. Perhaps this question can be resolved if we pose a still more basic question: When can we anticipate making a comparatively large capital outlay for either overhaul or replacement?

In some few cases we may be able to make such a prediction if we know that certain trends in equipment design will make superior equipment available in the foreseeable future. In more cases, however, we can reasonably predict that under given operating conditions certain classes of equipment will require a major overhaul after a definite period of use, and that the comparatively large expenditure required at that time will make it desirable to consider the purchase of superior equipment. Thus, the time of major overhaul represents a point of potential obsolescence as well as the first stage of physical wear.

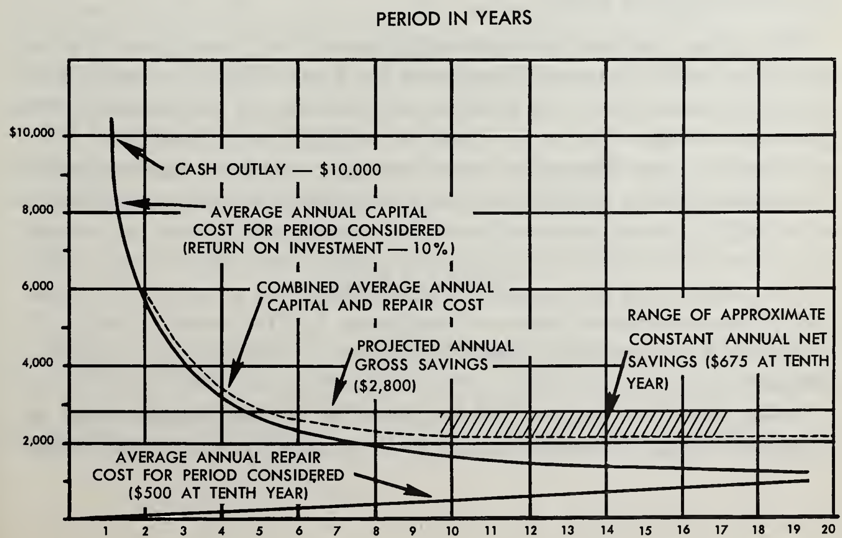
This reasoning can be applied to a great number of types of equipment in a company that has a progressive equipment policy. It is not arbitrary in the light of the fact that repair cost patterns have a direct effect on the decision to overhaul; and the fact that as repair costs increase, the need for overhaul *or* replacement becomes more urgent. A graphic representation of annual capital cost and repair cost will show that their combined total will reach a minimum point, after which it becomes less economical to operate a piece of equipment unless repair cost is reduced by overhaul or replacement. (Of course, if obsolescence occurs before overhaul, that shorter period should be used as the service life.) To illustrate:

EXHIBIT II shows the relationship between the average annual capital cost (the solid curved line) and the average annual repair cost (a straight line), as well as the resultant of the two costs (the broken curved line), for a machine tool costing $10,000. Projected average gross annual savings amount to $2,800 throughout the assumed service life of ten years (the straight line parallel to the time-axis).

In this case we are using a 10% return on investment which results in an average annual capital cost of about $1,625 at the tenth year. (If return on investment were not considered, this figure would be $1,000.) The average annual repair cost at ten years is $500, as we have seen from a previous example.

The area between the straight line representing the annual gross savings of $2,800 and the broken curved line, which is the total of average annual capital and repair costs, shows the range of annual net savings over the period considered. This net savings remains fairly constant over a wide span (the hatched area), and a service life selected in this range would for practical purposes give savings of the same magnitude.

EXHIBIT II. COMBINED EFFECT OF AVERAGE ANNUAL CAPITAL COST AND AVERAGE ANNUAL REPAIR COST ON ANNUAL GROSS SAVINGS



This result reflects realistically the problem usually presented when deciding to overhaul or buy. The range of error is acceptable on practical grounds. Seldom can we decide exactly when to take action, but usually we can make a decision within a reasonable period without adverse effect. Such a decision can be influenced by the present or anticipated availability of equipment, the price level of equipment, imminent improvements in machine design, as well as those factors involving capital availability, cost savings, and other plans of management.

CAPITAL INVESTED

An equipment replacement decision is usually concerned with the net outlay of cash involved and the relative certainty of having the expenditure returned within the period of the replacement's predictable use.

For analysis, the capital invested is converted to an annual cost basis. This value, in effect, is the annual payment the savings must cover to amortize the investment and also to provide a return on investment. For a given service life and percentage return requirement, the savings can quickly be determined on the nomogram (EXHIBIT I). For example, assuming a $10,000 investment to be amortized over a ten-year service life, and at a 10% rate of return, the savings figure is determined as follows:

> From the point where the 10% curve intersects the ten-year vertical line read over horizontally to the left to find the value of the worth factor on Scale *W* (about 6.25). Set a straight edge on this value and line it up on Scale *C* with the equipment cost of $10,000. Where the straight edge extended intersects Scale *S* is the amount of savings required per year, in this case about $1,625.

SALVAGE OR RESALE VALUE

The capital cost for a particular application is of course lower if at the end of its period of use the equipment has a cash salvage or resale value (including the value of its possible use elsewhere in the business). The question is whether this factor should be brought into the analysis.

In general, since the typical manufacturing company is not engaged in the used machinery business, it is doubtful whether it could predict terminal salvage or resale value with enough accuracy to improve the analysis. One more guessing factor is introduced against which the real cash outlay of the present must be measured. If future value has a bearing on a selection between alternative pieces of equipment, it is far better to think of it in terms of comparative salability than to try to give it a numerical measure.

It does sometimes happen, however, that the salvage or resale value can be predicted with reasonable accuracy—for example, in short-term installa-

tions like trucks or other automotive equipment. In such cases there is real point in making use of predicted terminal value. Suppose that in the problem above we wish to take account of a resale value of $2,000. The solution is then modified as follows:

Proceed as before to determine the worth factor, Scale *W*. Use the net value of $8,000 on Scale *C*, instead of $10,000, which points to a savings value of $1,300.

Then, multiply the salvage value ($2,000) by the rate of return (10%) and add the result ($200) to the savings. The answer obtained is $1,500.

The salvage or resale value of the equipment being replaced is a different matter. The old equipment makes its contribution to progress by reducing the cash outlay for its replacement. And the problem is figured simply as if the cash outlay for the new equipment were that much less. (This will work out differently from use of predicted terminal value of the new equipment, of course, because of the time-value of the money over ten years.)

Adjustment for the effect of the capital gains tax can well be made in the salvage or resale value of the equipment being replaced. However, the age of the equipment (no matter whether it is comparatively new, and no matter whether it represents an imprudent original choice) has no relevance here. Neither does the undepreciated book value except as it bears on the size of the capital gains tax. The old equipment represents sunk cost that cannot be recovered, and only its present value can be counted as cash and can be used to reduce the cash outlay for new equipment.

In effect, the study starts from the point where money is to be spent. Both present values of old equipment and future values of new equipment should not be used in the same problem. That would be double counting, if we are dealing with a series of replacements as in any progressive company. The future value of new equipment at the time of a given replacement will always come into play in the form of present value of old equipment at the time of the next replacement; and it certainly cannot be taken credit for then if it has already been used. So, considering the vagueness of the economic cycle, the simplest and surest approach is to take account only of the cash-in-hand salvage or resale value of the old equipment.

NET SAVINGS

The net annual savings of a proposed replacement is the difference between the annual gross savings and the total of the annual capital cost and the annual cost of wear over the service life. Let us refer to the problem covered by the discussions on "Service Life" and "Capital Invested."

Here the net annual savings can be summarized as follows:

Annual gross savings		$2,800
Less:		
Average annual repair over ten years	$ 500	
Average annual capital cost	1,625	2,125
Net average annual savings		$ 675

As discussed earlier, the annual gross savings should be based on an average value of utilization. Theoretically, if the year-to-year values are not equal, an adjustment must be made for the time-value of money. Unfortunately, exact projection of utilization is a difficult, if not impossible, task. However, we should at least have some idea of the practical result of taking an average:

In effect, savings have a larger present worth in the earlier years. So in the case of a gradually declining volume of production, the annual gross savings figure is only slightly understated by an unweighted average based on the straight total of year-to-year figures divided by the number of years. As a practical matter no correction is needed except in extreme cases.

The reverse is true for a rising volume. A useful procedure here is to solve the problem first on an average basis, and then test for a minimum volume condition. Where the change in volume is drastic, as in the typical case of a build-up for a new product over many years, it is advisable to consider the savings for each year on a present-worth basis.

PRIORITY OF A REPLACEMENT

Having passed the first test of a reasonable utilization during the period of capital recovery, the proposed replacement must then compete with other worthwhile replacements in their demand on capital funds, by a comparison of net annual savings. Those replacements with the largest net savings should receive prior consideration. However, there are other matters that must be kept in mind:

Before a final selection is made, the replacement proposals should be evaluated in light of the company's future plans regarding markets, products, resources, and the general business outlook. It should be emphasized that the net savings figure is not the criterion which determines the final decision but only a valuable (perhaps the most valuable) bench mark.

Also entering into the replacement decision will be the comparative risk involved. Generally, those replacements with short capital recovery periods will show better net savings, thus simplifying the problem of selection. Sometimes, however, equal net savings are available from other projects with longer recovery periods. While no rigid rule can be established in choosing between such alternatives, the replacement with the shortest recovery period may be more desirable from the standpoint of less risk. Again, however, there is no substitute for good judgment; there are plenty of factors that can make the opposite decision the wise one.

Some replacements are mandatory. Usually these problems involve a decision of whether to overhaul old equipment or to buy new equipment, where failure to take action would result in loss of sales. The net savings calculation, with potential profit loss not included, might show a negative value. Since in such a case we are interested in the alternatives of major overhaul versus replacement, the proposition involving the smallest net loss may be the more desirable.

This priority approach to replacement analysis requires that a planned replacement program be in effect, since a comparison between replacements cannot be made unless all possibilities are surveyed prior to selection. The use of a standard capital return period can serve as a stopgap measure, but this approach will not provide a basis for matching capital funds and replacements for the best return over the future course of business. In fact, an annual review of possible replacements is desirable. Management then can evaluate the savings potential and plan the allocation of funds or acquire the necessary capital.

No general rule of thumb can be devised to determine how much money should be allocated to equipment replacement. Obviously, there could be a great number of machine tools eligible for replacement if funds were unlimited, since there has been much recent progress in the designing and building of more efficient equipment. An answer to this problem should consider alternative uses of capital, accumulation and use of depreciation reserves, interest rates, the involvements of equity financing, and the inhibiting effects of lack of financial freedom on future growth. Of course there may be no choice but to go ahead if competitive conditions require improvement in cost and quality.

EFFECT OF TAXES

The fact that replacement is designed to increase profits means that taxes will be higher as a result. As it is, the annual gross savings figure in the replacement analysis does not include this effect. It seems only sensible to take account of the tax on increased income accountingwise through the aggregate profit and loss statement, where it will have a logical effect on the question of how much to engage in replacements in general. That is a better way to handle it than by applying a flat percentage to savings figures designed to facilitate the choice of specific replacements.

After all, our purpose in the procedure described here is to compare the desirability of alternative replacements. And the tax on increased income would hardly change their relationship since it would affect all savings figures in the same proportion. (Should it be desired to consider the tax effect in the calculation, the percentage return on investment figure would be adjusted upward to include the nominal effect of taxes in relation to investment.)

Note that the value of the capital expenditure in a replacement analysis will include expenses not normally classified as capital items, which in the usual accounting treatment would be charged directly against profit and loss and thus would reduce taxes. The accounting treatment, of course, makes this distinction between investment costs (depreciated over time) and operating costs (expensed in the current year), whereas a replacement analysis seeks to measure the cash outlay of a replacement over the whole period of its utilization. Here accounting is simply serving a different purpose; it must maintain stability in the determination of profits from year to year, and it must take account of tax requirements.

More fundamentally, the difference is between a broad picture of the results of all decisions at one point in time (accounting treatment) and the deep picture of all the results of one decision projected as far as they go (replacement analysis).

DEPRECIATION

There may be more point in not ignoring the effects of depreciation on income taxes, for these will vary between contemplated replacements. The higher depreciation charges made possible by the new capital asset will tend to reduce taxes and will thus reduce the total net cash outlay of the company; and the bigger the asset, the greater the effect. Further, when the asset is removed from the capital asset account at the end of its useful life to the company, the undepreciated amount will tend to reduce taxes (though the reverse possibility also exists that the salvage or resale value received may exceed book value and thus tend to increase taxes).

The practical fact is, however, that such tax effects may be indeterminate for a particular problem. Thus:

> The Internal Revenue Code of 1954 provides for a company's taking larger depreciation allowances (up to 200% of straight-line depreciation in the first year of acquisition of an asset), which can act to defer taxes as well as to accumulate reserves that are more commensurate timewise with the real depreciation of the equipment. Undoubtedly, the full advantage of these liberalized depreciation provisions can be realized by companies that follow a vigorous replacement policy and have asset accounting procedures that can take advantage of this law. In general, however, the possible advantages cannot be reduced to clear-cut rules. They must be reviewed individually in light of the current and anticipated tax situation, as well as in light of their impact on the profit and loss statement and the cash position.
>
> Again, the net salvage value of one replaced machine tool may be offset by the write-off of others, and hence no net capital gain is involved. It would, therefore, be difficult to set up a general rule regarding salvage value to guide the operating organization in analyzing this factor. In some replacement procedures, a 25% capital gains tax is arbitrarily applied to net salvage value, which in effect is a discounting device to prevent its overstatement.

While any such tax effect, if significant and measurable, should of course be considered, it should not be injected into the replacement study where it is only likely to confuse the analysis. It is usually sounder to make the analysis primarily on the basis of good engineering and business judgment, with the tax effects brought to bear subsequently.

MAKING A DECISION

While the approach to a replacement should be formalized in a step-by-step procedure, some flexibility must be maintained to allow the use of assumptions. Thus, one case may be clear-cut since it involves an obvious cost savings based on an ascertainable volume; whereas another may require working back to the volume and savings required to support a proposed replacement.

The following problems, which illustrate the method of analysis I am advocating, have been selected to suggest the scope of its application, but hardly cover every possible situation.

Of course, to look at each of these problems separately, as we shall be doing, is to run the risk of not putting enough emphasis on the over-all problem of considering the various proposals on a priority basis. But perhaps it will suffice to point out, once again, that this is more than a matter of comparative net savings or any other stereotyped formula; the final answer depends on the use of judgment in the light of the many principles we have been discussing throughout the article.

PROBLEM #1

Present equipment—One milling machine and one vertical drill press, built in 1942 and 1935, respectively. Net resale value comes to $1,050. Cost to overhaul this equipment and provide new tooling to achieve a yearly cost savings of $1,000 is $6,000. Useful life after rehabilitation is five years.

Proposed equipment—The operations performed by the old equipment can be accomplished in a single operation by a single ram broach at a direct labor savings of $0.108 per unit. Volume has built up over the past three years to 60,000 units per year, and it is anticipated that this volume will hold for the next four years.

On this basis, the savings per year are calculated as follows: Plus factors are direct labor, $6,480; indirect labor, $300; labor fringe benefits (15%), $1,020; normal maintenance and repair, $250; scrap and rework, $50—a total of $8,100. Minus factors are property taxes and insurance, $600. Annual gross savings therefore amount to $7,500.

Cost of new equipment, including installation, is $16,850. Subtracting resale value of old equipment results in cash outlay of $15,800.

Other considerations are (a) anticipated time before major overhaul—ten years; (b) estimated average annual repair costs over ten years—$384; (c) required return on investment—20%; (d) standard capital return period—two

years. Note also that this is standard equipment and can be used on other applications.

Solution—Solving by use of the nomogram (EXHIBIT 1) for a savings of $7,500 and cash outlay of $15,800 gives a capital return period of about three years.

Solving for net savings of new equipment:

Annual gross savings		$7,500
Less:		
Average annual repair costs	$ 384	
Average annual capital cost	3,750	4,134
Net average annual savings		$3,366

Assuming a possible error in annual volume projection over the next ten years of about 40% (24,000 units), the annual gross savings would be $4,519. The resultant net savings figure is $385.

Repeating the procedure for the alternative of overhauling, the capital return period for the $6,000 outlay and yearly savings of $1,000 is definitely longer than the 22 years covered by the chart. Solving for net savings of overhaul over extended five-year life, a rapid calculation on the nomogram shows that the annual capital cost of $6,000 for five years is $2,000. This exceeds the yearly savings, and would be still less favorable if projected repair costs are considered.

Decision—Although the period of return exceeds the standard two-year period, we can be sure that the equipment will be utilized for the calculated three-year return period. The net savings of $3,366 over the ten-year service life is attractive. The annual volume could be reduced by 40%, and the replacement would still produce a net savings that will give the required return of 20%. Since the alternative of overhaul does not give comparable savings, purchase of the equipment is recommended. Because of its attractive net savings and relatively short capital return period, the replacement undoubtedly would compare favorably with others on a priority basis.

In calculating the three-year return period in the above problem the effect of repair cost was not considered, since over this length of time it would not be significant. When long return periods are involved, the annual gross savings should be reduced by the average predicted repair cost for the calculated period, and the capital recovery period re-solved. This is a method of successive approximations, but is sufficiently accurate.

PROBLEM #2

Some types of equipment, because of their basic function, do not improve sufficiently in speed of operation to make present equipment obsolete. Some stamping presses are in this category. Consider the alternatives of equipping a 25-year-old press with a modern friction clutch versus purchasing a new press whose operating superiority over the overhauled press would mainly be in maintenance costs. The clutch installation plus a substantial overhaul will cost $8,800, as compared to a new press cost of $18,000.

Using the nomogram, at a 20%-return requirement and a 22-year life, the annual capital cost of the new press is $3,750. Projecting for the overhaul alternative, with a life of about 10 years, its annual capital cost is $2,100. The differential of $1,650 must be provided by the lower maintenance costs of the new press.

Experience with this type of equipment, however, does not indicate such possible savings, and therefore it appears more advisable to install the modern clutch and reconsider a new press at a later date. This conclusion is also based on the fact that the present frame and load-carrying members are sound. The reason for considering replacement at this time was the unsafe operating condition of the present clutch.

PROBLEM #3

Sometimes equipment is bought to increase sales volume by adding capacity, and in this situation it becomes necessary to determine what sales increase is required to support the equipment.

Take the case of a small shop of 30 people which was contemplating a $12,000 milling machine to broaden its scope. A 15% return was considered reasonable, and the proprietor felt that capital should not be tied up for more than three years. Using the nomogram, the income (Scale S) required to return the investment at 15% would be about $5,000. At a 10% profit rate the corresponding sales would be $50,000.

An inquiry among present and potential customers showed that this increase in business was reasonable becaue of increased versatility. A finer analysis of the problem, of course, would consider the effect of volume on fixed costs and taxes; however, the rough approach to the problem serves as a starting point.

The nomogram can be used to evaluate different conditions of capital return periods and percentage on investment, to help arrive at a conclusion. For example, if the amount of increased business had resulted in only a $4,000 incremental profit, then the return would be only about 5% over three years. At five years it would be 20% but at a greater time risk.

ORGANIZATION FOR REPLACEMENT

An equipment replacement program and the analyses involved require a two-way communication between top management and the manufacturing organization, as well as with other functions, such as sales, accounting, and product engineering.

The equipment requirements of the manufacturing organization to produce at less cost and with better quality must be compared with available capital. The yardsticks necessary to make this evaluation depend on information, such as sales forecasts, that the manufacturing group alone cannot determine. Furthermore, a close working relationship must be established between the manufacturing and engineering organizations in designing and manufacturing for cost and quality.

Equipment proposals usually originate with the manufacturing organization, but often they are made in conjunction with other departments. A replacement analysis form, covering the information discussed previously, is desirable since it provides a step-by-step guide for accumulating the necessary data. All information concerning costs, volume, utilization, personnel, calculated capital return period, and savings should be summarized

on the form so that a concise document is available for review purposes and for a record that can be used in a future audit to check the actual results obtained. The procedure used should be explained in detail to the organization and should be installed gradually, since each replacement problem must sell itself in regard to the practicability of its answer, before the method will receive general acceptance.

Above all, it must be recognized that a replacement program is only one facet of the day-to-day problem of increasing the manufacturing efficiency of a company. In the background must be the proper motivation to develop new ideas, which provide the need for many replacements. While setting up a replacement committee, or assigning specific individuals to the task, may expedite a replacement program, a broader basis for results can be obtained by emphasizing that equipment replacement ideas are part of the everyday job.

The fact remains that such ideas must be evaluated in terms of understandable ground rules, so that they can be compared for decision and so that their acceptance or rejection can be explained to all those in the organization concerned. The method of replacement analysis should make it clear that equipment must be utilized, and that the capital invested must produce a return in addition to being amortized. The method set forth here emphasizes these concepts, and reduces the financial mathematics involved to a mortgage-payment approach such as can be understood by most people.

42. THE ARITHMETIC OF CAPITAL-BUDGETING DECISIONS

Ezra Solomon*

The author discusses considerations of considerable importance in the decision-making process. He is primarily concerned with the proper use and understanding of mathematical concepts involving the evaluation of future benefits.

In order to make correct capital-expenditure decisions, corporate management needs at least three sets of information. Estimates must be made

* From *The Journal of Business*, XXIX, 2 (1956), 124-29. Reprinted by permission of the University of Chicago Press.

of net capital outlays required and future cash earnings promised by each proposed project. This is a problem in engineering valuation and market forecasting. Estimates must also be made of the availability and cost of capital to the company. This is a problem in financial analysis. Finally, management needs a correct set of standards by which to select projects for execution so that long-run economic benefits to present owners will be maximized. This is a problem in logic and arithmetic. This paper is concerned exclusively with the last of these three problems.

With respect to the question "Should this investment proposal be accepted or rejected?" the problem of arriving at a correct decision is uncomplicated. Either one of two approaches to measuring the investment worth of a proposal will provide a correct answer. In the usual form in which these approaches are used as capital-rationing criteria, they are:

The rate-of-return approach.—This approach expresses each project's estimated value as a single over-all "rate of return per annum." This rate is equal to the rate of interest at which the present value of expected capital outlays is exactly equal to the present value of expected cash earnings on that project. The concept is identical with the "effective yield to maturity" on a bond that is purchased at some price other than its par value. It has also been called the "internal rate of profit" or the "marginal efficiency of capital."

If the rate of return on a project is greater than the company's cost of capital (also expressed as a percentage per annum rate), then the project should be accepted.

The present-value approach.—For each project, find the present value of the expected capital outlays, using the cost of capital as a discount rate. Likewise, find the present value of the expected cash earnings. If the present value of earnings is greater than the present value of outlays the project should be accepted.

These two approaches give the same results for "accept or reject" decisions. This is so because the computed rate of return on a project will be higher than the cost of capital in all cases for which the present value of earnings, discounted at the cost of capital, is greater than the present value of outlays. Or, conversely, if a project promises a rate of return greater than the company's cost of capital, then the present value of its earnings, discounted at the cost of capital, will be greater than the present value of its outlays.

For problems which involve more than a simple "accept or reject" decision, the application of these two criteria, as they are generally defined, often yield contradictory or ambiguous results. The purpose of this paper is to explore the reasons for these contradictions or ambiguities and to reformulate this general approach to measuring investment worth so that it always provides a unique and correct basis for decision making.

MUTUALLY EXCLUSIVE PROPOSALS

It is often necessary for management to ask not only "Is this project worth undertaking?" but also "which of two projects is the better one?" This latter question is crucial whenever two or more projects or proposals are mutually exclusive. For example, the proposals may be alternative ways of doing the same thing. Both might be profitable in an absolute sense. But since only one of the two can be undertaken, the problem is to decide which alternative is the better one.

When the *relative* merit of alternative proposals is at issue, the rate-of-return criterion, as defined earlier, and the present-value criterion, as defined, can yield contradictory results. With the increased interest in applying rational approaches to the solution of capital-investment decisions, this possible conflict between the two generally acceptable criteria has received renewed attention. Several recent papers have shown that when projects are ranked by the rate-of-return standard, the results may differ from a ranking of the same projects based on the present-value standard. For analytical purposes, the simplest example of such a conflict will suffice: Assume that there are two investment opportunities available. Both are profitable in an absolute sense, but only one can be undertaken because the two are mutually exclusive.

Project *X* requires an outlay of \$100 now, at time t_0, and promises to return \$120 exactly 1 year hence at time t_1. Project *Y* also requires an outlay of \$100 now and promises to return \$174.90 exactly 4 years hence at time t_4. Assume also that the degree of certainty attaching to each project is identical and that the investor's present "cost of capital" is 10 per cent.

The "rate of return" on project *X* is 20 per cent, and on project *Y* it is 15 per cent. The present value of project *X*, discounted at the cost of capital, is \$109.09. For project *Y*, the present value, discounted at the cost of capital, is \$119.46. If the two projects are ranked by their rate of return, project *X* is the better one. If, on the other hand, they are ranked in terms of present value, project *Y* is the better one. Which should the investor choose?

In order to resolve the problem correctly, it is necessary to isolate the source of the conflict between the two approaches. The easiest way to do this is to compare the two investment proposals in terms of their relative value as of the terminal date (t_4) of the longer-lived project.[1]

According to the data given, proposal *Y* will provide the investor with \$174.90 at time t_4. All we know about proposal *X* is that it provides \$120.00 at time t_1. What happens to these funds between time t_1 and t_4 is obviously an important piece of necessary information. Neither the

[1] The "terminal date" refers to the date at which cash earnings from the longer-lived of the two competing projects cease.

rate-of-return approach nor the present-value approach answers this question *explicitly*. But they both answer it *implicitly* and in different ways. This is the source of the conflicting results that they yield.

Those who use the rate of return approach, as it is usually defined, would choose project X over project Y. Hence they must assume that this choice will yield a larger terminal value than that promised by project Y, i.e., \$174.90. This, in turn, implies that the \$120 obtained from project X at time t_1 can be reinvested between time t_1 and t_4 at a rate lucrative enough to accumulate to more than \$174.90 by time t_4. *In general*, the implicit assumption made by the rate-of-return approach is that the reinvestment rate is at least equal to the rate promised by the longer-lived of the two projects, in this case, 15 per cent.[2]

The present-value approach, as usually defined, assumes that the funds obtained from either project can be reinvested at a rate equal to the company's present cost of capital, i.e., 10 per cent. Using this assumption, the investor will end up at time t_4 with only \$159.72 if he chooses project X. With project Y, he would have \$174.90. Thus, according to this approach, project Y is the better choice.

The question of which assumption is likely to be the more justified one is important, but it is not relevant to the argument being made in this paper, namely, that the apparent conflict between the two approaches results only from differing assumptions that each makes about the future. If a common assumption is adopted, both approaches will always rank projects identically.

Let us assume, for example, that the investor can put money to use between time t_1 and time t_4 at an average return of 12 per cent. The following computations and results would ensue:

Terminal value.—For project Y this is \$174.90. For project X we have \$120 at time t_1, plus interest at 12 per cent per annum for 3 years. This would accumulate to \$168.47.

Rate of return.—For project Y this averages 15 per cent up to the terminal date at time t_4. For project X the rate would be 20 per cent for 1 year and 12 per cent for 3 years—an over-all rate equal to 13.9 per cent.

Present value.—For project Y this would be \$174.90, discounted from time t_4 back to time t_1 at 12 per cent and back from time t_1 to t_0 at 10 per cent. This gives \$113.17. For project X the present value would be \$120 discounted from time t_1 to time t_0 at 10 per cent, or \$109.09.

All three criteria rank the two projects in the same order. With the particular assumption we used, project Y is the better one by any standard. Using some other assumption, the ranking might be reversed, but the alternative approaches would still yield identical results.

[2] For example, if project Z, a third alternative, yielded 15 per cent in perpetuity and project X yielded 20 per cent, the rate-of-return approach would choose project X over project Z. Hence the approach must assume that funds received from project X can be reinvested at least at 15 per cent.

Our conclusion is that correct and consistent ranking of the investment worth of competing proposals can be obtained only if the following factors are taken into account:

1. The valid comparison is not simply between two projects but between two alternative courses of action. The ultimate criterion is the total wealth that the investor can expect from each alternative by the terminal date of the longer-lived project. In order to make a fair comparison, an explicit and common assumption must be made regarding the rate at which funds released by either project can be reinvested up to the terminal date.
2. If the rate of return is to be used as an index of relative profitability, then the relevant rate is the per annum yield promised by each alternative course of action from its inception to a common terminal date in the future (usually the terminal date of the longer-lived project).
3. If the present value is to be used as an index of relative profitability, the expected reinvestment rate or set of rates should be used as the discounting factor. These rates will be equal to the company's present cost of capital only by coincidence. When comparing two projects requiring different outlays, it is necessary to compare "present value per dollar of outlay" rather than the absolute present value of the projects.

THE PROBLEM OF "DUAL RATES OF RETURN"

In a recent paper Lorie and Savage[3] have drawn attention to a second problem involving the arithmetic of capital budgeting. In this paper the authors attempt to show that certain rare and complex investment situations exist which cannot be expressed in terms of a single, unique "rate of return." In such situations the application of the usual prescription for finding *the* rate of return yields two solutions, and thus "the rate-of-return criterion for judging the acceptability of investment proposals, as it has been presented in published works, is ambiguous or anomalous."

In order to understand the problem involved, it is helpful to recognize two basic types of investment situation, classified according to the pattern of estimated cash flows that are projected. In the usual type of situation, which we will call "pattern *A*," the stream of net cash inflows promised by a project ends either before or when it reaches that point in time beyond which the value of *net future flows* is negative. In other words, the project is assumed to terminate before the stage beyond which its continuation yields a net loss to the investor. The second situation, which we call "pattern *B*," is a much rarer one. Projects which fall into this category continue beyond the point defined previously, i.e., the terminal section contains a net cash outflow (a net loss). Such a pattern obviously exists only if there are contractual or other compelling reasons which make it impossible for the investor to avoid the terminal losses.

[3] James H. Lorie and Leonard J. Savage, "Three Problems in Rationing Capital," *Journal of Business,* XXVIII (October, 1955), 229-39.

As far as pattern *A* projects are concerned, it is always possible to express the investment worth of the project as a single, meaningful "rate of return" and hence to make a clear-cut decision on the basis of such a criterion. For pattern *B* projects the application of the usually prescribed method of finding the appropriate "rate of return" can yield more than one answer:

Let us take a specific example of a pattern *B* investment project. The proposal being considered is the installation of a larger oil pump that would get a fixed quantity of oil out of the ground more rapidly than the pump that is already in use. Let us assume that, by operating the existing pump, the investor can expect $10,000 a year hence and $10,000 two years hence. Let us assume that, by installing the larger pump at a net cost of $1,600 now, he can expect $20,000 a year hence and nothing the second year. The installation of the larger pump can be viewed as a project having the cash-flow characteristics shown in Table 1.

TABLE 1

Time Period	*Incremental Cash Flow Due to Investment*
t_0	− $ 1,600
t_1	+ 10,000
t_2	− 10,000

The usual prescription for finding the rate of return of a project is to find that rate which makes the discounted value of net cash flows equal to the discounted value of capital outlays. Alternatively—and this amounts to the same thing—find that rate which makes the algebraic sum of the discounted cash outflows and inflows equal to zero. The application of this method to our example will yield two answers, namely, 25 and 400 per cent. In other words, using a 25 per cent rate, the discounted value of the cash flows is exactly equal to the outlay of $1,600. However, a rate of 400 per cent also equates cash flows with capital outlay. Which of the two "rates" is the correct measure of the investment worth of the project, 25 or 400 per cent?

The answer is that neither of these rates is a measure of investment worth, neither has relevance to the profitability of the project under consideration, and neither, therefore, is correct. The fault lies in the incorrect application of the "usual prescription" for finding the rate of return. A closer look at the implications of defining the rate of return in this context as that rate (or rates) which reduce the discounted cash flows to zero reveals the gross error that such a process entails. In order to find this error, let us vary the net outlay required to install the larger pump (keeping all other cash flows constant) and solve for the "rate of return," using the usual prescription. We get the following absurd results:

1. If the larger pump costs nothing, then the project is worth 0 per cent, i.e., at 0 per cent, the discounted value of the net cash flows is equal to the value of the outlay.

2. If the larger pump costs $827, the project, according to this method, suddenly becomes quite profitable and is rated at 10 per cent, i.e., at a rate of 10 per cent, the discounted value of the net cash flows is equal to $827.

3. The more the pump costs, the more "profitable" the project becomes! At a cost of $1,600 the rate of return is 25 per cent; at a cost of $2,500 it yields 100 per cent. The method would have us believe that the engineer who first thought of the idea of installing the larger pump could have a gold mine if only he could persuade the pump manufacturer to charge him enough for the installation!

Needless to say, any definition of "profitability" that leads to these absurd results must itself be in error.

The correct solution for the investment worth of the project is simple and straightforward. But it requires an explicit answer to a relevant question: "What is it worth to the investor to receive $10,000 one year earlier than he would have otherwise received it?" This is actually all that the installation of the larger pump achieves. If the investor expects to be able to put the $10,000 to work at a yield of x per cent per annum, then getting the money a year earlier is worth 100x$. If x is 23 per cent, for example, getting $10,000 a year earlier is worth $2,300. In other words, if he spent $1,600 on the larger pump now (at time t_0, he would end up at time t_2 having $2,300 more than he otherwise would have had. This can be stated as an equivalent "rate of return," which in this case would be about 20 per cent ($1,600 at 20 per cent per annum would amount to $2,304 at the end of two years). Using this approach, a unique and meaningful rate of return can always be found for any set of cash inflows and outflows.

SUMMARY

The rate of return is a useful concept that enables us to express the profitability of an investment proposal as a single explicit value. This value automatically adjusts for differences in the time pattern of expected cash outflows and inflows. It is also independent of the absolute size of the project. Thus it provides a useful standard by which all types of projects—large and small, long-run and short-run—can be ranked against each other in relative terms and also against the company's cost of capital, in order to judge their absolute worth. The arithmetic involved in rate-of-return computations is generally straightforward. However, there are two situations in which such computations require a careful consideration of the logic that is involved.

1. When mutually exclusive proposals are being compared, it is necessary to compute the rate on each alternative course of action up to the terminal date of the longer-lived alternative. This requires an explicit estimate of the yield to be derived from the cash flows generated by each of the alternatives being considered.

2. When a rate is being computed for complex proposals that have negative terminal values, the usual mechanistic prescription for solving for rates does not apply. This situation also requires an explicit estimate of the yield to be derived from incremental cash flows generated by a project. Given this estimate, the equivalent dollar value of the incremental cash flows can be computed explicitly. A comparison of this value with the outlays required for the project will give a correct and unambiguous measure of the project's rate of return.

If these concepts and methods are used in defining and computing rates of return, this criterion will always provide an unambiguous investment standard, the use of which will lead to a maximization of the investor's net present worth, insofar as the estimates used are accurate.

43. CAPITAL BUDGETING—HOW TO USE IT CONSTRUCTIVELY*

The article discusses the factors which should be present in a capital budgeting program emphasizing the point that an over-all view of the company, its present and prospective environment, are of importance.

Today's manager is equipped with a growing number of tools to help him with the complex issues he must decide. He has devices and techniques like computers, research designs, management theory, and linear programing to serve him in a host of areas; many of the traditional basic management decisions have been softened up by the impact of such new developments.

However, managers have frequently determined the allocation of dollars to specific capital investment programs according to the smell of the economic breeze at the moment or the relative powers of persuasion of the company personnel who hammered on their doors. The off-again-on-again nature of some widely publicized recent capital projects is all

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* From *Association of Consulting Management Engineers Reporter*, 1958, pp. 1-5. Reprinted by permission of the Association of Consulting Management Engineers, Inc.

too convincing evidence of the haphazard nature of many investment decisions.

The dangers in this situation are obvious. In the first place, the quality of capital-budgeting decisions is central to the stability and progress of a company. The mistakes and the benefits are locked in for a long time to come. Secondly, the state of the whole economy suffers from poorly based and improperly analyzed choices. Without any firm guidelines, some businessmen tend to turn thumbs down because of hunches about the future—and thus help bring about the very problems they fear. Such decisions have been likened to riding a bicycle: if you slow down and keep changing your mind all the time, you are in danger of falling off.

In a time of recession and uncertainty, like the months through which we have been passing, unsystematic capital budgeting reduces our chances of an upturn and, at the same time, tends to push the curve down even further. By the same token, a period of less active business presents an opportunity to the more alert company—*if* it can shake off the adverse psychology. For the cost of new plant and equipment is usually lower; and if in addition it will add to present efficiency, the company can put itself in an excellent position to compete when the market for its products picks up again.

Indeed, capital budgeting can be thought of as setting the framework for decision making about the future of the business. It is difficult to bring together technical, marketing, economic, and financial considerations, but it is essential—and capital is the one element common to all departments. Thus the capital-budgeting mechanism largely determines the size, scope, and ultimately the long-run profit of a company. It is a fortunate juncture that improvement in forecasting and analytical techniques has taken place simultaneously with the increased need for systematic handling of this crucial function.

Though the specific problems the manager faces vary widely by company and by industry, all executives have some of the same basic problems. Furthermore, a body of currently useful generalizations and procedures has been worked out which can be helpful in many situations. They break down into four rough questions:

1. How can desirable projects be generated and screened?
2. What decisions have to be made in finding the needed dollars?
3. How can executives select the best projects?
4. Where in the company hierarchy should the decisions be made?

Let us look briefly at each of these key problems.

GENERATING AND SCREENING IDEAS

First of all, what is a "capital expenditure?" Though some companies restrict the term to plant and equipment, others use much more flexible definitions. Some include any expenditure which does not produce a

quick return on the investment—for example, management training, institutional advertising, major research, or large scale public relations activities. Other firms establish a rough criterion which sweeps in any nonrecurring items related to facilities as capital investments. But whereever the particular dividing line may be drawn, it is clear that many successful firms and most management specialists go beyond the stiff technical definitions of the accountants and the tax lawyers.

How can good ideas be stirred up, and who should do it? Though any aggressive and imaginative group of top managers can themselves be expected to develop good ideas for projects and to spot holes which need plugging, the largest number of suggestions seems to come from below. And the livelier the company, the more ideas come boiling up from the needs and dreams of the lower echelons.

One multiproduct firm noted for its advanced system of capital budgeting approved some 650 projects for a twelve-month period recently; hundreds more had been suggested, but failed to pass through the series of ever-finer screens set up between the birth of the ideas and their ultimate acceptance.

There are, of course, many ways to stimulate suggestions. Not the least of them is the creation and maintenance of a climate which encourages individual initiative and creativity. Some of the most exciting research expeditions at the moment are exploring and mapping the vast and mysterious territory of the human mind and the generation of new ideas.

Furthermore, intense analysis of areas like technological advances, the position of competitors, and a company's cost structure can turn up fruitful ideas. But many managers have found that the most effective way to stimulate useful suggestions is through comprehensive long-range planning.

In one organization, for example, divisions look ahead five years for each of their products and for new items just emerging from the laboratories. They study product life, costs, competition, sales percentages, and marketing alternatives until they have developed a set of concrete goals for themselves. This process inevitably turns up capital expenditure projects since the plan cannot be fulfilled without new facilities or programs.

Long-range planning can be justified on its own merits. But its usefulness in providing a soil for the germination and flourishing of new ideas, particularly major capital programs, cannot be overestimated.

Unfortunately, many companies do not integrate their long-range plans, if any, with capital budgets. Division managers are permitted to take depreciation reserves and spend them on capital projects without regard for the needs or opportunities of the rest of the company. No over-all strategy is worked out and coordination between the divisions breaks down. Capital items are launched on the basis of the division manager's

judgment, thus reducing the maneuverability of the firm as a whole. Top management in these organizations has tied its own hands, and has abdicated one of its most far-reaching responsibilities.

Once a crop of items has been harvested, how can executives sort and classify them as a preliminary step to deciding which will be developed further?

Many firms first take a close and specific look at programs proposed for the next year or two, always within the framework of a long-range plan. One study showed that almost two-thirds of the firms sampled reviewed their projects monthly. While this degree of frequency might well tend to tie decisions too closely to the ebb and flow of general conditions, it seems obvious that projects to be undertaken in the next year or so should be sorted out from those proposed as part of a five-year plan, and be given first priority.

As a next step, many managers build up some kind of system, tailored to meet individual circumstances, by which they can classify suggestions and measure them against each other. Though a host of different categories are possible, many companies start off with two moves.

1. They link all the individual items that are designed to accomplish a single aim. For example, if breaking a production tie-up requires several new pieces of equipment in different parts of the plant, expenditures for all of them are considered as one project. In addition, any costs associated with such secondary projects as new materials handling devices, plant rearrangement, or retraining of personnel which may be required are included under the one heading.

2. They divide capital investments according to their purpose. "What is the item supposed to accomplish?" not "What is it?" governs their choice of a category.

Labeling of the various pigeon-holes depends on the needs of the particular organization. Some observers have suggested the following breakdown as a helpful one:

Expansion items, which create added facilities and the subsidiary services necessary to increase or launch production and sales of either existing or new products.

Product improvement expenditures which meet or surpass competition in existing lines through better quality, packaging, design, advertising, and so on.

Cost reduction programs, including replacement of equipment, which reduce company expenses by plant redesign, supervisory training, manufacture of parts instead of purchase, or by other means.

Necessity tasks which have to be undertaken by law, for the protection of employees, or for other reasons which directly and immediately affect the company's ability to stay in business.

Strategic investments, like management training, institutional advertising, and basic research which have a healthy, though gradual, impact on the whole firm.

The point is not that there is any inherent priority in one category over another, or that this is necessarily the best kind of classification for

all companies. Any manager may be able to fashion a better one for his own purposes. Rather, the usefulness of this process of classification is simply that it helps managers to think through their needs and opportunities more concretely and fruitfully.

FINDING THE NEEDED DOLLARS

The cash for capital expenditures will have to come from the time-honored sources: internal funds—mostly retained earnings and depreciation reserves; or external financing—primarily sale of securities or assumption of debt.

Historically the emphasis has been on using internal funds, and many businesses make it a rule to finance capital projects solely from earnings. But both approaches have their problems.

When a management group decides to use exclusively internal funds for capital projects, it tends to turn first to funds provided through depreciation reserves. The trouble is, of course, that these funds are often insufficient even to replace existing equipment. Inflation has eaten away at the funds, costs have gone up, and technological advances have made the old equipment obsolete. Some companies prepare for this situation by setting replacement instead of historical cost as the figure for depreciation allowance; others set up larger contingency funds or special reserves.

The major issue to be decided in the use of retained earnings is how much money is to be paid out in dividends and how much is to be plowed back into the firm. Studies have shown that companies which turn back a high percentage of their earnings into capital investments stand in danger of depressed stock values and proxy fights. On the other hand, inflated dividend payments may impoverish a business by sopping up replacement reserves and with them the opportunity for future growth and prosperity, especially in an age when any organization has to move forward very fast if it is even going to stand still. Some kind of balance must be struck.

One especially acute specialist has pointed out that the practice may well be different for large and small firms. The latter, after all, are often selected as speculative investments by the stockholder, so managers can afford to sacrifice current handfuls to future bushels. Large, established companies, however, need to maintain a reputation for high and stable returns.

The central issue in external financing is the cost of capital as determined by market value of money, flotation charges, and the company's capital structure. Often it can be estimated by taking the average figure for past issues under similar conditions. But each of the three major elements should be examined to see how any fluctuations might affect the total picture. Sometimes the risk is out of line with the probable return on the investment.

There are, of course, a host of other decisions which have to be made in the area of external financing. Will it sacrifice equity and if so, how much? Will management's freedom of action be restricted by provisions imposed by the lender? Will the organization's credit rating be damaged? Will fixed capital costs rise too high? All these are interrelated, and bear on capital budgeting by controlling the amount of money available to fill the demands.

SELECTING THE BEST PROJECTS

In a vigorous and expanding firm the demand for capital is likely to be greater than the supply. Under these circumstances, how can one request be selected over another?

Some businessmen have used the length of the pay-out period—the time it takes the return to earn the amount of the investment—as a yardstick. But for many projects this is impossible since there is no neat and measurable end-point. Furthermore, it overlooks the extended profitable life which some projects are going to have over others.

Another device is simply "postponability." "What can we chop off this year?" they ask, "and what do we absolutely have to do now to keep the roof from falling in?" The trouble with this oversimplified device is that it presupposes no over-all company strategy, but feeds and feeds upon a crisis concept of management. There is, after all, no inevitable matching of a project's postponability and the money that it can make for the company. Municipalities often select their capital expenditures on this basis.

Many companies have found that return-on-investment is the most satisfactory way of grading different projects. Some cannot be classified that way—notably "necessity" investments, some of those with indirect, long-term benefits like major public relations projects or management training, or strategic proposals like the search for a specific technological breakthrough. But these can be judged on their urgency or general desirability when the proposals have been sorted out and assigned priorities on some uniform basis.

It should be pointed out here that careful forecasting is required if the return-on-investment figure is to be valid. There are a number of methods for computing this figure, the most widely accepted of which are the discounted cash flow method and a formula established by the Machinery and Allied Products Institute. Both methods derive return-on-investment from calculations and comparisons of all elements of income and costs.

By putting the available funds and the graduated list of demands together, a minimum rate of return can be established. In other words, the point where the supply and demand curves intersect marks a theoretical standard; any items falling below this mark can be rejected.

In practice, of course, no such rigid line can be set. The supply of

money is not that inflexible, nor are the predictions upon which the two curves are based that foolproof. But the figure thus established does give management a yardstick by which to reject a number of suggestions. While there are a number of ways to figure return on investment, the differences are less important than the fact that the company has taken the step of choosing one procedure and using it as a way to compare alternative opportunities on a uniform basis.

Some companies simply set the graded list of projects against the funds available and work down to the point where the funds are exhausted. But management judgment almost inevitably comes in at the general area where supply and demand meet, because otherwise some high-return opportunities might be overlooked. This forces a re-examination of the supply figure set at the list of projects which have been suggested. Actually, it is dangerous to wash out management judgment and try to establish some mechanical guide. The grading process is useful in that it makes clear which expenditures are obviously sound and which should obviously be left out. But it never can make the fine distinctions which have so much to do with a company's competitive position.

One final point: Rather than invest everything down to the last dollar, many wise managers hold a reserve fund available to provide for emergencies.

MAKING THE DECISIONS

From all that has been said, it is clear that sound capital budgeting demands an over-all view of the company, its possibilities, and weaknesses, general economic and political conditions, the total supply of managerial manpower available, and many other pieces of information. As a matter of fact, most of the suggestions in this article tend to push the process up in the management hierarchy.

The final authority, of course, is the board of directors, which usually reviews all capital expenditures over a certain amount. The rules governing clearance vary from company to company, but in general it is true that management has much wider latitude in obligating for operating expenditures than for capital expenditures. This is an implicit recognition of the long-run significance of the capital investment program.

This does not mean that the screening process—the review of objectives for the long-range plan, divisional proposals, detailed projects, and so forth—should not be handled at various places along the line. In one company, for example, capital budgeting starts with the establishment of broad divisional and company objectives by top management after review of initial product-by-product proposals from below. Then specific sales and profits objectives, as guides for the future, are set for each product, and rated lists of capital projects are sent up by divisions to group general managers. From there they go to a top-management committee for final

formulation of the capital expenditures budget based on a figure arrived at by the key executives after consultation with the treasurer.

Front-office decision-making does not mean, either, that careful training and post-mortems throughout every echelon are not important. Capital budgeting is at once a complex and a decisive process in any company, and should be widely understood and constantly improved. Actual project outlays and returns should be compared on a periodic basis against original estimates. Such a post-mortem not only serves to keep departmental estimates realistic, but it also provides a basis on which techniques for projecting sales, costs, and margins may be made more accurate and useful.

A FINAL QUESTION—WHEN?

In a period like this, dominated by extraordinary difficulties in forecasting, the question of timing is especially tough and especially important. Mistakes will not be hidden or softened by rising sales, as they usually are in a growth economy.

In the interest of the economy as a whole, stability of investment practice is of course to be desired. But it is not likely that many companies will feel they can afford to be so altruistic as to go ahead just on that basis.

It should be said, though, that the spread of the practice of long-range planning throughout our business community, accompanied by increased knowledge about how to plan effectively, should tend to encourage managers to level off the wide swings in capital expenditures. A close examination will develop many more good opportunities for new capital investment than are expected. Furthermore, the more executives responsible for capital expenditures take advantage of the tools of modern management, the more stable and the sounder their decisions are likely to be.

44. HOW TO FIND THE MOMENT WHEN MODERNIZING PAYS BEST*

The article compares the "discounted cash flow" approach of Joel Dean with the "next-year rate of return" approach developed by George Terborgh for Machinery and Allied Products Institute (MAPI), both of which can be used as helpful guides in arriving at certain decisions in the capital assets area. The illustrations are helpful to an appreciation of the broad objectives of both approaches.

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* From *Business Week*, Sept. 1958, pp. 100-102, 104, 107, 108, 111, 112, 114, 116, 118, 119. Reprinted by permission of the publisher.

"There are two ways to go broke running a business," says Cloud Wampler, of Carrier Corp. "One way is to spend too much, the other is to spend too little."

Finding the line in between is management's never-ending duty. For if a company spends too much on its plant it can be loaded with excess capacity that eats up profits. If it spends too little, creeping obsolescence and rising production costs will do the same thing, and its more alert competitors can dig its grave.

Yet making investment decisions for replacement or modernization is, in the words of Pres. Charles W. Stewart of Machinery & Allied Products Institute, "the most backward management area today." It is, he says, "the most backward because it's the most difficult."

And it is the most difficult because a welter of questions faces any businessman who tries to set up a rational policy for keeping his plant and his company's money producing at their best rates. Each question affects the next, yet all are affected by broader developments that he can't hope to control.

Present Pressure—The problem hasn't always been so pressing. In the lush days of the 1955-1957 capital goods boom and in many earlier post-war years, industry's investment in new plant and equipment was prompted chiefly by a heavy flow of orders. Companies couldn't handle the demand without adding to their capacity.

Today, though, many companies have enough capacity to meet the increases in sales that they expect in the near future. The fundamental problem has changed: They must decide whether to replace their existing equipment without significantly expanding their capacity.

So the questions that managements must try to answer when they want to decide whether to modernize their plants become even more complex.

FLYING BLIND

The welter of questions has scared off many managements in the past. And many still base their decisions on technical necessity, or hunch, or some rule of thumb.

Some meet the problem with the Neanderthal approach. A 30-year-old machine in the company's plant refuses to turn over one day. The machine shop boss walks in, kicks it, and bits of the machine fall all over the floor. He says, "Get rid of that piece of junk." And he buys a new machine. That's all he knows about why he replaced the machine, and whether it was sensible to do it.

For a few years, at least, his company probably paid out more to operate and maintain that machine than the machine itself brought in from its production.

Hunches & Politics—Usually though, management's replacement decisions are a bit more refined than this cave-man approach. They'll often

have in them a high degree of hunch or judgment. You can't rule out the importance of these two factors in business decisions, especially where guesses about the unknowable future, or the strategy of competitors, are involved.

It is, in fact, the essence of management to make decisions that cannot be figured out by a formula. At best, a formula will narrow down the number of possibilities and risks in a business decision. But it's still up to management to select the risk that fits best with a company's objectives. And these objectives are factors that can't be programed into a computer —hunch and judgment are still vital. But unless they're backed by rational analysis, they can land a company in deep trouble.

Business' rule of thumb approaches, still the basis for investment decisions in hundreds of manufacturing companies, do call for some facts and figures. But the answers they provide can easily turn out to be meaningless.

I. FIRST REFINEMENT

One of these approaches sets out to establish the "payout period." Its great lure is its apparent simplicity and conservatism. It tells—or would tell if it were properly computed, which it usually isn't—how fast a company can get its money back out of an investment in an asset that's wasting and will one day be junk.

Payout System—Here's how it works: Joe Kelly, head of the Flugelheim Machinery Co., thinks his plant may need a new piece of equipment to replace a 30-year-old automatic screw machine. The new screw machine, which works faster, will cost him $15,000.

He has analyzed his business and found that the new machine will save him $5,000 a year, before taxes, in operating costs.

So he reckons the payout period is three years. It will be six years if he figures income taxes at a 50% rate. It will be less if he also figures his tax savings from the depreciation allowance on the new machine. And depending on what other factors he tosses in—the money he gets from scrap sale of the old machine, the cost of the money he uses for the new one—he will get other answers.

But if the object of all his figuring is to make sure that his company recovers the original cash outlay as quickly as possible, then any answer he gets will be meaningless.

The important question isn't how fast funds will flow back into the company's treasury. If he doesn't make the investment, then he has already got his funds back without waiting at all. What matters is how much the investment will yield beyond the payout period.

Valuable Lesson—Calculating the payout period and coming up with an answer that indicates an investment in new equipment will pay off rapidly may teach a company one thing. It may show that the company has been

operating with such high-cost equipment that returns come in rapidly on whatever it spends for new machinery.

But to go on operating with ancient equipment until the payout period is very short is like beating your head against a wall to see how good it feels when you stop. The longer you beat, the better it feels when you stop—provided you haven't killed yourself in the meantime.

II. REVERSE TWIST

To escape some of the pitfalls that trap managements who base investment decisions only on calculations of the payout period, some companies try a reverse approach. They seek to base their decisions on the rate of return of a new investment.

Here's how Mr. Kelly of Flugelheim Co. would try, with the aid of this system, to make his decision on whether to buy that new $15,000 automatic screw machine:

"The new machine will save me about $5,000 a year in direct labor and maintenance costs. But I have to figure my depreciation allowance on it. On the depreciation basis we're using, I can write it off in 20 years. And to round it out over the 20 years I'll just knock off a standard $750 a year for depreciation. That means the return to me is $4,250 a year.

"I'll still have my income tax to take out of that—say 50%. So if I buy the machine I'll net $2,125 a year more than if I don't buy it.

"Since it costs me $15,000, I'll be getting a rate of return of 14%. And that sounds pretty reasonable."

The Gaps—Or is it as reasonable as Mr. Kelly thinks?

It almost certainly isn't. And the reason is that this rate of return system is about as faulty as the payout system. Both suffer from two critical flaws:

Neither helps a businessman find the real cost of the capital eaten up by his investment in a new machine. The capital cost isn't simply the price of the new machine. The businessman should also allow for the money he gets by selling the old machine for junk, and for what he saves by avoiding further maintenance costs on the old equipment. And he can't rely on the Treasury's depreciation tables for a sure guide to the fall in the new machine's value. The decline in its real earning power and the nominal year-by-year write-off of its book value are two quite different things.

Neither gives a businessman any means to compare the price he has to pay for a modernization project with the present value of the stream of anticipated earnings from this project—or with the yields from other possible projects, or with the advantages he might gain by delaying his modernization plans for a while. When a businessman buys a new machine, he is, in a sense, buying an annuity that consists of the income he expects to make from the machine. The investment will be good or bad

according to whether the capitalized value of the annuity is greater or less than what he pays for the machine.

But how, then, do you estimate the value of the annuity?

THE SCIENTIFIC APPROACH

The two men who have done most to find the best way of answering this question—and to help businessmen base investment decisions on more solid grounds—are George Terborgh, research director of Machinery & Allied Products Institute, and Joel Dean, professor of business economics at Columbia University's Graduate School of Business, and also president of his consulting firm, Joel Dean Associates.

Can't Do Everything—Neither claims to have developed an exact science for decision-making, or to have found ways for answering all of a company's questions in this area of investment. Neither claims that his system of analysis can be any better than the facts and estimates that are fed into it. Each agrees that those facts must be determined by the nature of the problem—not, as Dean's associate Winfield Smith says, "by the nature of the logic machine."

But a good logic machine—a good formula—does help management:

It demands that it be fed with the essential data about productivity, costs, taxes, and so on.

Working with it, a management can get consistent guides to different investment decisions—the alternatives can be compared because the same kind of data has to be produced about each one.

I. DEAN'S SYSTEMS

Joel Dean's method goes by the name of Discounted Cash Flow. It, too, aims to measure the rate of return of an investment—but in a way that takes into account all those factors that aren't considered by the simpler systems. For Joel Dean, the rate of return means the discounting rate which makes the expected flow of net earnings from new equipment equal to the cost of the new equipment. This rate of return can be compared with other rates from alternative investments—and with a company's costs of capital—as a guide in setting up the company's capital budget.

Scheduled Returns—Finding this measure of a project's worth involves setting up a timetable that shows the effect the project will have on the cash flows of a company during each year of the project's duration.

After the net effect of the project on the flow of cash into the company has been worked out for each year ahead, this stream of receipts is continuously discounted to discover the rate of return of the investment.

How Joel Dean Finds the Value of an Investment in a $15,000 Automatic Screw Machine

(Condensed version)

FIRST, you make these basic estimates . . .

Years from Installation Date (1)	Capital Outlays Incurred or Avoided (2)		Operating Improvements & Cost Savings (3)	Tax Depreciation New Machine (4)	Tax Depreciation Old Machine (5)	Increase in Taxable Income (6)=(3)—(4)+(5)	Difference in Income Taxes at 50% Tax Rate (7)=50% of (6)
0	New machine cost Old machine rebuilding avoided Old machine salvage received	−$15,000 +4,000 +300	—	—	—	150	−75
0-5			22,500	6,429	2,000	18,071	−9,035
5-10			16,250	4,643	2,000	13,607	−6,804
10	Another machine rebuild avoided	+4,000	—	—	—	—	—
10-15			10,000	2,857	2,000	9,143	−4,572
15-20			3,750	1,071	2,000	4,679	−2,340
20	New machine salvage received Old machine salvage foregone	+750 −300	—		—	225	−112
TOTALS		**−$6,250**	**52,500**	**15,000**	**8,000**	**45,875**	**−22,938**

This is the crucial estimate and it's most important in the first 10 years of the new machine's life. The savings expected in later years add little to present worth, as you can see in column 9, because they are so heavily discounted.

These aren't in themselves cash flows. But from them you can calculate the taxes in column 7, which are cash flows.

The minus signs in this column mean that taxes will be higher because earnings of the new machine are higher.

NOW, you can compute the rate of return . . .

Years from Installation Date	Net Cash Flows (8)=(2)+(3)+(7)	Present Worth of Net Cash Flows at 23% (9)
0	−10,775	−10,775
0-5	+13,465	+8,183
5-10	+9,446	+1,825
10	+4,000	+395
10-15	+5,428	+342
15-20	+1,410	+27
20	+338	+3
TOTALS	**+23,312**	**0**

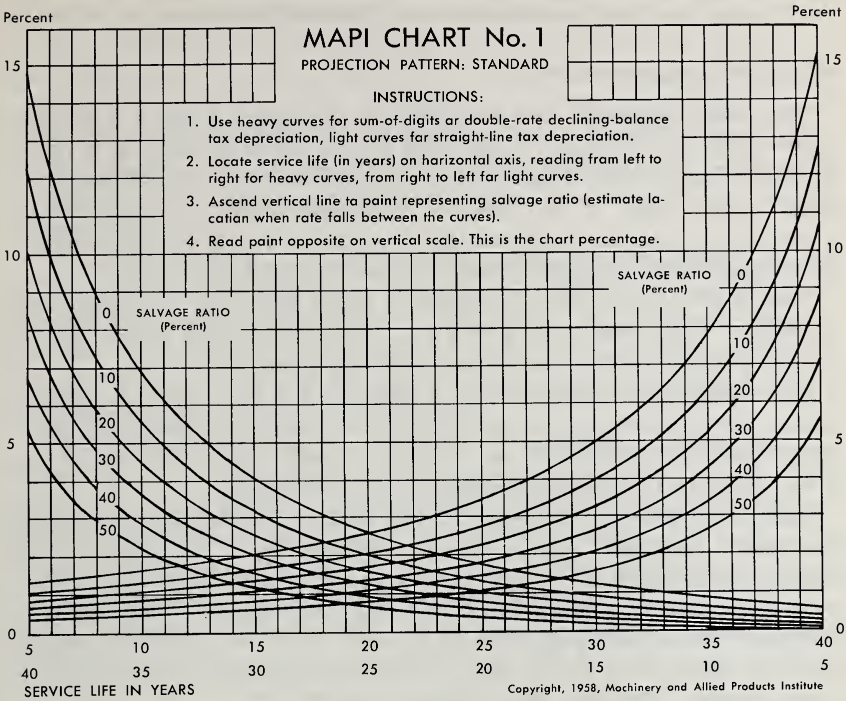
The purpose of column 9 is to find what discount rate, when applied to the income stream shown in column 8, will make the present value of the entire stream equal to the adjusted net cost of the investment. In this example, the rate is 23%. When it is applied to each item in column 8, you will find that the present value of that whole income stream just offsets the cost of the investment — and so, column 9 adds up to zero.

The tough and crucial part of the analysis is to make reasonable estimates of the cash inflow that the investment should yield each year of its life. But this shouldn't be too onerous a task for a management. Some estimate of the probable flow of returns is the essence of any investment decision.

To see how Dean's system works, there is, below, a condensed version of the timetable of cash flows that Dean would build to estimate the worth of Flugelheim Co.'s proposed investment in that new $15,000 automatic screw machine—on the assumption that the new machine will yield a before-tax net return of $5,000 in the first year—a return that, as the machine wears out, will diminish by 1/20th in each succeeding year.

Dean's measure of the project's worth is there at the head of column nine—the 23% discount rate, which is the project's rate of return.

MAPI'S MASS PRODUCED AID TO BUSINESSMEN—THE CHART THAT SOLVES THE TOUGHEST PART OF THE MAPI REPLACEMENT FORMULA.



This 23% figure is the crucial one. Pres. Kelly of Flugelheim Co. can compare it with the return he would get from alternative investments, to see which was best. And by discounting the net cash flows at a rate equal to his company's cost of capital—say, 10%—he can also compute the present worth of the new screw machine to find what the machine for which he pays $15,000 is really worth to him. This calculation of present worth can be important to a company that sells or leases equipment and wants to decide what price to charge its customers.

Custom-Built—Dean has not worked out in advance a set of standard formulas for projecting and combining the expected net returns, the costs of capital, the company's debt ratio, or other key variables involved in an investment decision. Each of his analyses and sets of projections must be custom-built. And that means that Dean's system isn't likely to be used for any but important investment problems, where the hoped-for gain in accuracy is likely to exceed the cost of the analysis.

Mr. Kelly obviously isn't going to call in Joel Dean to find out whether to get that one screw machine. If he were looking for a quick, relatively reliable way of handling his problem, he would probably do better to have his engineers tackle the analysis with the MAPI formula.

II. FORMULA FROM MAPI

The MAPI approach was developed by economist George Terborgh (BW—July 30 '55, p. 84) in 1949. Since then he has been working to make it more effective—but to make it more simple, too. Now MAPI has published a new study of his, Business Investment Policy, which seeks to make from a complex mathematical formulation a do-it-yourself investment analysis kit to help businessmen, engineers, and accountants.

The MAPI formula aims to produce a figure called the "next-year rate of return." That's the return you'll get from an investment in new equipment if you make it now, rather than wait one more year.

This figure gives a businessman a guide to the time when the return from a capital investment is greater than the cost of the funds he'll have to use, than the return that his company usually seeks from its investments, than the returns available from other investments.

Basically, Terborgh's next-year rate of return is the same as Joel Dean's discounted cash flow rate of return. Terborgh gets his rate-of-return figure for the whole life of the investment by a standardized way of estimating the capital consumption cost of the new machine. Dean builds a complete, tailor-made projection of this cost of the new machine during its entire anticipated service life. Where Dean custom-builds his long-range forecasts, Terborgh mass-produces them.

What's Involved—The company that uses MAPI's technique to guide its decisions has to sort out five different factors that go to make up that "next-year rate of return."

First, the analyst must figure the operating advantage to be gained from the new equipment: How will it affect direct and indirect labor costs? Maintenance? Tooling and supplies? Down-time for repairs and time for scrap and rework? Inventories? Power costs? Will it need more or less floor space? And will property taxes and insurance go up or down? And, since most modernization projects are not simply one-for-one replacement jobs, production volume or product quality will probably change —and the change will be worth money. The sum of all these things makes up the project's operating advantage.

Then, there's capital consumption avoided: If the new project is delayed for a year, the old equipment in the plant may need some money spent on it to keep it going. This is the equivalent of a new investment and at least part of the cost of overhaul should be regarded as a capital cost charged to the year. Moreover, there'll probably be a drop in the

old machine's disposal value after another year's use—just as the trade-in value of a car declines after an extra year's use.

Third, there'll be added income tax. This has to be subtracted from the gains represented in the formula's first two factors.

Next, there's the cost of consuming the capital that's to be spent on the new equipment. This is the tough part, the factor that George Terborgh and his MAPI colleagues Eric Schiff and Richard MacNabb have labored mightily to simplify. Toward that end they have produced a set of standardized charts—one of them is printed above—from which a businessman can easily work out an approximation of his project's first-year capital consumption cost.

The charts themselves are produced from an elaborate mixture of: the rate at which the new project's earnings will decline; the service life of the new equipment, its final value for sale, trade-in or scrap; the corporate tax rate, the company's depreciation system; the ratio of the company's debt to its total investment, the interest rate it pays on borrowed capital, the after-tax return it gets on equity capital.

The MAPI charts have pre-computed all these things. They have assumed that a 25% debt ratio, a 3% interest rate, and a 10% after-tax return on capital are about the normal for most companies. There are three charts—because MAPI offers the analyst three general patterns in which the earnings of a new machine will decline over the years of its service life. In some cases, the annual earnings produced by the new machines will have declined by one half by the time they have worked half their service life; in others, annual earnings will have declined by only one-third when the machines' service life is half over; and in some cases, annual earnings will have shrunk by two-thirds when half the new machines' estimated service life is gone.

The fifth large piece of the MAPI formula is the net investment in the project. This is far simpler. From the total cost of buying and installing the new equipment, subtract the money you get from salvage of the old machinery and the money you would have had to spend to keep the old stuff going.

How It Works—Pres. Kelly of Flugelheim Co. might shy away from these apparent complexities when trying to decide whether to get that new $15,000 automatic screw machine. But if he persisted he would find that it is a great deal easier to solve his equipment replacement problem with MAPI's formula than to struggle unaided through his company's corporate income tax return.

Here's how he would do it with no more than one sharp pencil and a couple sheets of paper:

Operating advantage: $5,000 cut in first year from cost of direct labor, maintenance, and so on.

Capital consumption avoided: Overhaul of the old machine would have cost $4,000, prorated over 10 years. So we can figure that we are saving $400 the first year by not putting money into the overhaul job.

Income taxes: From the total of those two—$5,400—we have to cut 50% for income taxes. That leaves a next-year after-tax advantage of $2,700.

Capital consumption costs: Now we turn to MAPI's charts. We're estimating that the new machine has a 20-year service life, that we'll get back 5% of its original cost when we finally sell it, and that its annual earnings will decline at a steady rate during the service life of the project. And, of course, we already know that we're using that method of depreciation for taxes known as "sum of the years' digits." So we follow the line on the chart that takes care of these things. And here at the side we get the answer: 2.3%. That's the proportion of the original cost of the project that we should charge off as the cost in the first year of using up our capital on this project.

The answer: 2.3% of $15,000 is $345. Subtract this from the after-tax advantage of $2,700—and it's $2,355. Now hold that figure while we get the last two elements.

The net investment: The total cost of the new machine is $15,000. But we take from that the $300 we get for salvage of the old machine and the $4,000 we would have had to spend to keep the old one going. Capital gains taxes on the sale of the old machine add $75. Result: $10,775.

Last step: What percentage is $2,355 of $10,775? That's the rate of return of the project. And the result is almost 22%.

This figure of 22%, which emerged from MAPI's pre-computed formulas, is almost equal to the 23% rate of return computed by Joel Dean's continuous discounting of anticipated cash flows. The two systems, using apparently different techniques, can chew up the same set of facts and estimates and spit out almost consistent answers.

Like Joel Dean's 23% rate of return, the MAPI 22% rate can be used to test the value of investing in that screw machine against other investment opportunities, or against Flugelheim Co.'s cut-off rate for this kind of investment project.

And if Kelly is still curious about the payout period of his investment, he can calculate it—with a far greater degree of realism—from either Dean's or MAPI's approaches. By either measure, his screw machine project will pay out in about four years, since it's yielding a rate of return of 22% or 23% each year on the original net investment.

III. IN THE FIELD

By now, any management man worth the title on his door will have spotted a factor that underlies all the estimates of earnings and costs. It is the forecast of the operating rate of the new machinery.

On that, everything else depends. And both Dean's and MAPI's formulas recognize that it's up to the businessmen themselves to work out the most probable operating rates.

For Management Only—No formula will tell a company whether it can keep selling the products it makes, whether the economy as a whole is set for a dip or a rise, whether competitors are about to sweep it off its foundations with a flood of new products.

The businessman still has to work these things out for himself and decide what the risks are. And because the value of investments in modernization depends heavily on these elements, neither Terborgh nor Dean claims any scientific precision for his system.

The question for management is not, "Can I get really accurate forecasts by using a more complex system?" It is, "Is this a sensible and efficient way to process all the different estimates about a modernization project? Does it force me to consider factors I've been neglecting? Does it help me to look ahead more clearly—and with a harder calculation of the probable dollar returns?"

Converts—The answer seems to be "Yes." At least, an increasing number of major industrial companies are using these more complex analytical techniques, and are finding that they work well—usually in adaptations to a company's particular needs. Many companies have made audits of the actual returns from new equipment and compared these with the forecast returns—with encouraging results.

Allis-Chalmers Mfg. Co. has used the MAPI system for several years, made post-audits in 1956 and 1957. It found the difference between the estimated gain and the money the company actually did gain was no more than 6%.

This was the record over seven of Allis-Chalmers' plants. Plant-by-plant, the estimates and the post-audits showed up far wider variations. But these were ironed out over the larger range of the company's operations, since the over-estimates and under-estimates for individual plants pretty consistently canceled each other out.

Balance for Error—Indeed, one of the purposes of the MAPI approach is to help a company consider the wide range of its operations when it plans to modernize. There's little use in analyzing a single machine or a single plant by these methods if a short-sighted system of organization and a lack of cohesion in a company jeopardizes the profits that can come from modernization.

Allis-Chalmers thinks the MAPI system helps it take a broad view of modernization. And so do many other users of the MAPI method—A. O. Smith Corp., Draper Corp., Cooper-Bessemer Corp., Ingersoll Milling Machine Co., ACF Industries, Inc., Barber-Colman Co., Link-Belt Co., and De Laval Steam Turbine Co.

Military for MAPI—One of the most important recent converts to MAPI's approach is the nation's largest machine tool owner—the Defense Dept. The Air Force alone owns 150,000 machine tools and about 50 large manufacturing plants, including installations like the Ford engine plant in Chicago and the Convair plant in Fort Worth.

The Air Force—and other services—are engaged now in a modernization drive and are persuading their contractors to replace inefficient tools from the Defense Dept.'s enormous inventory. The drive has two aims: to cut the cost of the military's end-items, and to get the best tools into use immediately.

But since most of its huge inventory of machine tools was built up during World War II, many of Defense's machines are obsolete. Many of them cannot, for instance, cut the exotic metals used in missiles and new airplanes.

So when a contractor wants Defense to pay for an expensive new machine tool for use on a relatively short contract, the department calls for the contractor to justify the spending of government funds by completing a modified MAPI analysis of the machine.

XII

PRICING POLICIES

45. MULTI-STAGE APPROACH TO PRICING

Alfred R. Oxenfeldt*

Mr. Alfred R. Oxenfeldt shows how management can make sounder decisions in pricing where formulas often fall short and even the sharpest judgment can be wide of the mark, by attacking the problem with the aid of a six step sequential plan.

Of all the areas of executive decision, pricing is perhaps the most fuzzy. Although unanimity in marketing decisions is a custom more remarkable in its occurrence than in its absence, agreement in pricing decisions is even more rare.

This article accordingly presents a long-run, policy-oriented approach to pricing which should reduce the range of prices considered in specific situations and consequently improve the decisions which result. This approach, which to the best of my knowledge is new, calls for the price decision to be made in six successive steps, each one narrowing the alternatives to be considered at the next step.

Is this method just another mechanical pricing formula? Hardly, for it is my conviction that the quest for mechanical pricing methods is unduly

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* From *Harvard Business Review,* XXXVIII, 4 (1960), 125-33. Reprinted by permission of the *Harvard Business Review.*

optimistic, if not downright naive. Nevertheless, many businessmen consistently employ almost mechanical formulas for pricing.

Yet, even if mechanical pricing formulas are the hope of the optimistic, it would be excessively pessimistic to resign ourselves to a *formless* consideration of all the relevant factors and to a random exercise of judgment.

SEQUENTIAL STAGES

In order to organize the various pieces of information and considerations that bear on price decisions, a multi-stage approach to pricing can be a very helpful tool. This method sorts the major elements in a pricing decision into six successive stages:

1. Selecting market targets.
2. Choosing a brand "image."
3. Composing a marketing mix.
4. Selecting a pricing policy.
5. Determining a pricing strategy.
6. Arriving at a specific price.

The sequence of the stages is an essential part of the method, for each step is calculated to simplify the succeeding stage and to reduce the likelihood of error. One might say that this method divides the price decision into manageable parts, each one logically antecedent to the next. In this way, the decision at each stage facilitates all subsequent decisions. This approach might also be regarded as a process of selective search, where the number of alternatives deserving close consideration is reduced drastically by making the decision in successive stages. Of course, one could arrive at the same result by simultaneously considering all the factors mentioned—but it might require a computer to do so.

While it appears that this approach is applicable over a broad range of industry and trade, the great diversity of business situations precludes the possibility of its being a universally applicable method. It must be adapted to prevailing circumstances; consequently, information, experience, and the application of rigorous logic are required for its optimum utilization.

1. MARKET TARGETS

A going concern is "committed," confined, and tied down by several important circumstances which can be altered only over a considerable period of time. It must live with many conditions, even while it may attempt to alter them. Also, an operating business possesses specified resources on which it will strive to capitalize in achieving its objectives. For example, a firm will have:

A fixed production location, given physical facilities, and a particular production and sales labor force.

A set of distribution arrangements through which the firm generally sells, including particular distributors with whom it has established relationships.

Contracts with suppliers, customers, laborers, and lenders of funds.

A portfolio of customers who have a definite opinion of the firm's reliability, and the quality of its offerings and service.

These commitments and resources of a firm contain pricing implications. Mainly, they determine the type of product that it can make, the type of service it can render, and its probable costs of operation. What is more, these circumstances form the basis for the most fundamental pricing decision that management should make—namely, the types of customers, or market segments, it will attempt to cultivate.

By virtue of its fixed commitments, then, a firm is limited to the several market segments it can reasonably hope to capture. It has customer connections on which it can capitalize, and it has a variety of strengths and weaknesses that limit its choice among potential submarkets for intensive cultivation. *One important criterion in the selection of market targets is customer awareness of and sensitivity to price.*

II. BRAND "IMAGE"

Once management has defined the submarkets it wishes to cultivate most actively, it must select the methods it will use to achieve its goal.

Success in the market place for more and more products seems to depend on creating a favorable general image (often vague and formless) of the product or company among prospective customers. The selection and development of this image become of prime importance and have a direct bearing on price, as will be explained subsequently. A favorable image is especially important when one sells consumers' goods, but only rarely is it completely unimportant even in the sales of producers' goods. Buyers' very perceptions are affected by their prior attitudes, the actions and opinions of others, first impressions and early associations. It is a rare firm that can ignore the total impression its potential customers have of it and of what it is selling.

The firm's selection of its company and brand image should be dictated by the types of customers it is trying to attract. Submarkets may be likened to targets at which the seller is firing, and "images" are powerful weapons that can be used to hit the targets.

Almost every going concern has invested—often very heavily—in the creation of a favorable image. Most businesses know what image they wish to achieve and are concerned lest they or their products fail to have a favorable "meaning" to potential customers. At the very minimum, almost every management knows there are certain images that customers might have of it and its product that would prove disastrous.

The type of image a firm can create of itself and its wares depends to a considerable degree, again, on its fixed commitments and resources.

With its physical and personnel resources, there is a limit to what it can do to alter the prevailing opinions—for they reflect all that the company was and did in the past. In that sense, the basic commitments limit the type of image a firm can establish, how much time it will require to establish it, and the cost. Even as brand image is frequently an effective weapon in cultivating particular submarkets, price helps to create the brand image. It is for this reason that the selection of a brand image which is consistent with the firm's market targets implies particular forms of price behavior.

III. MARKETING MIX

The third stage in multi-stage pricing calls for the selection of a combination of sales promotion devices that will create and re-enforce the desired company and product brand image and achieve maximum sales for the planned level of dollar outlays. In this stage, a role must be assigned to price. The role in which price is cast should be selected only after assessment is made as to the relative effectiveness and appropriateness of each sales promotion device that might be employed. The short-term gains of certain sales promotion devices may entail injury to the image objectives of the firm. Conflicts of such a nature must be resolved at this stage.

Then, too, a firm might achieve precisely the *desired* image and still find customers very hard to get. It is not enough to establish the desired image; it must be an *effective* image. Furthermore, even though a firm may establish highly favorable impressions of itself and its wares, the company and its products must live up to the image they foster. Not only must its product be "within reach" in price, but it must be accessible by being offered through convenient channels of distribution, and must be sold in outlets where customers like to buy.

The third stage builds directly upon the second. The need to conform to the prior decision about company and brand image greatly limits the number of price alternatives that a price setter can reasonably consider.

The marketing-mix decision at this stage need not be translated into specific dollars and cents amounts to be devoted to each sales promotion device; however, it does at least call for crude answers to the following questions:

How heavily to advertise?
How much for salesmen?
How much for product improvement?
How much of an assortment to carry?
How large an inventory to hold?
How best to provide speedy delivery?
How much emphasis on price appeal?

The composition of a marketing mix (arrived at by answering the type of questions just listed) is admittedly very difficult and highly subjective. But the job is facilitated greatly when answers are subjected to the test of conforming to the desired company and brand image and to the firm's fixed commitments.

Few firms can afford to switch "images," usually because they have invested heavily in them in prior years and should, therefore, not abandon them lightly. Moreover, past images persist and blur any future attempts at image building. Although it cannot easily scrap its brand image, a firm can vary its marketing mix within moderate limits and remain consistent with the image it seeks to create. Thus, the selection of an image sets limits and gives direction to the decision about the elements to be included in the marketing mix. In that way, it facilitates the decision and also increases the likelihood that it will be correct. However, it does not isolate a single marketing mix as the only correct one.

IV. DETERMINING POLICY

The fourth stage in multi-stage pricing calls for the selection of a pricing policy. But before a pricing policy can be determined, answers to the following questions must be obtained:

How should our price compare with "average" prices in the industry? Specifically, should we be 2% above or 4% below the average? And, when we speak of the average, which firms' prices are we going to include in the computation?

How fast will we meet price reductions or increases by rivals?

How frequently will it be advisable to vary price? To what extent is stability of price advantageous?

Should the firm make use of "fair trade" price maintenance?

How frequently should the firm run price promotions?

These are simply illustrative of the aspects of a pricing policy which management can and should spell out—in proper sequence. By virtue of having made the evaluations and decisions called for in the first three stages, management will find itself limited in the number of choices on these points.

In addition, each company must take account of the valuations placed on its product-service "package" as well as the valuations of rival products by the market segments it is most anxious to cultivate. On the basis of such considerations, plus its target market segments and marketing mix, it will decide whether it can afford to charge much more or less than its rivals.

"Bracketing" the Price—Before proceeding further, let us summarize. Surely, a price setter would be some distance from a specific price decision even after completing the fourth step. We must ask ourselves

whether he would not also have covered considerable distance toward a price decision. By taking account of the firm's basic commitments and resources, the images it desires to establish, its decision about marketing mix, and the selection of a detailed pricing policy, has not the price setter reached the point where he is very strongly circumscribed in the price decision he will ultimately make?

V. PRICING STRATEGY

It is difficult to draw a sharp line between policy and strategy, but it is possible and useful to make some sort of distinction between them. Policy is formulated to deal with anticipated and foreseeable situations of a recurrent type. However, markets frequently are beset and dominated by *special* situations that basic policy was not designed to meet. For example:

A Congressional committee might threaten to investigate the company's or the industry's pricing arrangements.

A sizable firm may have fallen into a desperate financial situation so that it was forced to raise cash through a liquidation of its inventories.

A large new firm may have entered the market.

Business may have fallen off precipitately for the entire industry or economy.

The company may have introduced a model that is either a "dud" or a "sure winner."

Special situations like these ordinarily require an adjustment in price—and the formulation of a strategy to guide management in setting price *during the time that the special situation endures.*

There generally are several strategies which would be compatible with the firm's basic commitments and resources, its market targets, its image objectives, its convictions about the relative emphasis to attach to various elements in the marketing mix, and its specific pricing policies. Others would be incompatible with earlier decisions and therefore might endanger precious values. A threat to one's very survival might justify a scrapping of these, but impetuousness, shortsightedness, or avarice would not. Explicit recognition of these earlier stages of the pricing decision should prevent hasty short-run actions that are painful, but quite common.

VI. SPECIFIC PRICE

Here is the final step—the selection of a specific price. At this point, the price setter will usually find himself sharply circumscribed in the specific sums he can charge. Nevertheless, he usually will have some range of price possibilities that are consistent with the decisions made in the preceding five stages of the price decision. How may he best select among the alternatives?

To the extent that he is able, he should be guided by the arithmetic of pricing—that is, by a comparison of the costs and revenues of the alternative prices within the zone delimited by the prior stages of his pricing decision. Once he has taken into account his market targets, brand image, marketing mix, pricing policy, and strategy, he can afford to ignore everything but the calculations of costs and revenues. *The first five stages of decision are designed to take account of the business considerations which may be ignored if one selects price solely on the basis of prevailing cost and revenue conditions.*

It often is impossible to obtain reliable information about sales at different prices; this difficulty is present whatever method of pricing one employs. But the multi-stage policy approach facilitates research and experimentation into demand conditions by limiting the number of alternatives to be considered.

The price that would be established under this multi-stage policy approach would rarely be the same as that set by balancing marginal cost and marginal revenue. The former probably would exclude, as incompatible with the firm's basic commitments and resources, desired brand image, and so on, the prices that would be most profitable in the very short term.

THE ADVANTAGES

First, this approach breaks up the pricing decision into six relatively manageable pieces. In that way, it introduces order into the weighing of the many considerations bearing on price. This approach, therefore, should increase the likelihood that all major factors will be taken into account and that their large number will not overwhelm the price setter.

Second, this method of pricing reduces the risk that the price setter will destroy the firm's valuable investments in corporate and brand images. Also, it requires the price setter to determine and take into account the limitation on the firm's freedom of decision. In that way, it would discourage the pricing executive from undertaking what he is powerless to accomplish. Similarly, the multi-stage policy approach should militate against a short-run policy of opportunism that would sacrifice long-term values.

Third, the multi-stage policy approach to pricing should be valuable to those executives who are compelled to delegate pricing responsibilities. In the first place, high-level executives are virtually required by the method to make the decisions for several stages, which thus limits their dependence on their subordinates. In the second place, as explained, it simplifies the making of a price decision so that greater success can be expected. Then, too, its use should make it easier for subordinates

to raise questions and obtain advice from their superiors, should they be unable to reach a decision.

Fourth, this approach to pricing puts considerable emphasis on the intangibles that are involved in pricing—particularly on the total impression that customers have of the vendor and of the things he sells. Price is far more than a rationing device that determines which potential customers will be able to afford to make a purchase. Generally it is one of the most important actions in creating an impression of the firm among potential customers. Especially as tangible differences among rival products shrink, these intangibles will grow in significance for marketing success.

THE LIMITATIONS

This approach does not indicate all the considerations that should be taken into account at each stage in the pricing decision. In other words, the price setter is compelled to isolate the significant factors operating at each stage and weigh them for himself.

Second, this approach does not indicate what price to charge in any specific situation. The most that can be claimed for it is that it narrows down the zone of possible prices to the point where it may not matter a great deal which particular price is selected. As stated at the outset, one must beware of any pricing method that does lead to a single price, for such a method could not possibly take into account all of the special circumstances which are relevant to a price decision and which vary so greatly from market to market and from time to time.

Third, this method does not guide price setters in recognizing the factors that dominate the market at any time and in knowing when to switch basic strategies. Also, there may well be more than one dominant condition which must be considered in selecting a basic strategy.

On balance, then, the multi-stage approach to pricing at best only takes an executive fairly close to his ultimate destination. Although the multi-stage policy approach does not do the whole job of pricing, the part of the job that is left is relatively easy to finish in many cases. Where this is not so, one can only assume that the task would be almost hopeless without the assistance of a method that reduces the pricing decision to a series of relatively manageable steps in a prescribed sequence.

CONCLUSION

The multi-stage policy approach outlined here differs from usual approaches to pricing in two major respects. First, it demands a long-range view of price by emphasizing the enduring effects of most price actions

on company and brand image. One might say this approach constructs a policy framework for the price decision. And, second, it allows the price decision to be made in stages, rather than requiring a simultaneous solution of the entire price problem.

46. HOW STANDARD COSTS ARE BEING USED TODAY FOR CONTROL, BUDGETING, PRICING: A SURVEY

Walter B. McFarland*

The author reports on a survey of standard costing practices which covers what standards actually are, what their relation is to actual costs, and for what purposes standards are used.

With the end of the war and resumption of production for peacetime markets, it became evident that there was need for renewed emphasis on the reduction and control of costs. A survey of postwar trends in cost control made a little over two years ago by the committee on research of the National Association of Cost Accountants, disclosed a strong interest in standards as an aid to management in its efforts to control costs.[1] In this survey it was found that most companies which had standard cost plans prior to the war were reviewing and improving these plans. Many other companies which had never used standard costs before were starting to develop them or were planning to do so. Hence a study of this subject was undertaken as one which promised to be timely and of practical value.

While standard costs are not new and a sizable literature on the subject has accumulated during the past thirty years, there have been wide differences of opinion with regard to their nature and application. Thus it seemed desirable to re-examine the whole subject in order, first, to develop a clear statement of fundamentals and, second, to determine how standard costs are actually used by those companies which have had experience with them. Conclusions reached were drawn from a survey

* From *The Journal of Accountancy,* LXXXIX, 2 (1950), 125-31. Reprinted by permission of the author and the publisher.

1 "Trends in Cost Control Practice," Research Series No. 9, *N.A.C.A. Bulletin,* March 15, 1947.

of previously published materials, from numerous unpublished case studies which have been collected in the NACA library files, and from a study of current practices of seventy-two companies using standard costs.

SURVEY OF THE FIELD

Since standard costs proved to be a broad subject, it seemed best to begin by mapping out the field. The results were presented in a form which we have termed an analytical report. In it the subject matter under investigation was outlined, terms defined, and relationships explored. Then additional reports were written to describe current standard cost practice in connection with cost control, costing of inventories, pricing, and budgeting.[2] This approach proved highly successful and has been adopted as more or less standard procedure. In summary, it consists of selecting a broad area of accounting practice for investigation, starting with an analysis which stresses relationships to other aspects of accounting and management, and following with a related series of reports presenting actual practice organized around the various purposes for which the techniques described can be used.

THE RE-EXAMINATION OF STANDARD COSTS

In the analytical study mentioned above, it was necessary to answer such questions as:

What are standard costs?
What is their relationship to actual costs?
For what purposes are standard costs used?

On re-examining these fundamentals it was seen that costs may be determined both before the fact and after the fact and that both predetermined and historical (or actual) costs have their place. In other words, management must look forward as well as backward and at the present. To make an important decision without first estimating the costs involved is to gamble rather than to manage. Equally bad is failure to determine the costs after the fact and to compare them with the advance estimates. A complete cost accounting plan thus must produce both predetermined costs and historical costs.

[2] For the full text of these reports, see "A Re-examination of Standard Costs," Research Series No. 11, *N.A.C.A. Bulletin*, February 1, 1948; "Standards to Aid Control of Manufacturing Costs," Research Series No. 12, *N.A.C.A. Bulletin*, March 15, 1948; "Standard Costs for Costing Inventories," Research Series No. 13, *N.A.C.A. Bulletin*, June 1, 1948; "Standard Manufacturing Costs for Pricing and Budgeting," Research Series No. 14, *N.A.C.A. Bulletin*, October 1, 1948; "A Standard Cost Case Study," Research Series No. 15, *N.A.C.A. Bulletin*, December 15, 1948.

Costs which are determined in advance may be estimates or they may be standards. The distinction between an estimate and a standard has provoked much discussion in the past. One of the best working definitions of a standard cost plan states that:

> . . . the criterion of a standard cost system should be primarily the existence of engineered standards—that is to say, the existence of underlying or quantitative standards developed by engineers and, in some instances, accountants to measure the amount of material, labor, and overhead factors which enter into the manufacture of a product. To these underlying standards there are assigned dollar amounts for the convenience of a common denominator. From the dollar standard so created, the internal cost accountants then measure the departures of actual costs as incurred.[3]

While the difference between an estimate and a standard probably depends largely upon how carefully the predetermined costs are measured, the distinction is not highly significant for practical purposes. Much can be gained by setting approximate standards where circumstances do not warrant greater precision.

The direct antecedents of modern standard cost-accounting methods were estimating-cost methods. Estimates of cost were employed for pricing products and for costing inventories before there was any formal cost accounting. With the scientific management movement came the development of industrial standards for use both in planning manufacturing operations and in evaluating the effectiveness with which work was being done. These early standards were engineering or physical standards expressed in methods, specifications for and quantities of material, and hours of labor. The fundamental standards used to plan and to control factory production are still of the same type. In time it was discovered that the same approach could be used in the control of manufacturing costs. This process developed in two directions:

1. Translation of physical standards into unit cost standards to be used in accounting for direct material and direct labor costs.
2. Development of budgets for controlling indirect costs which were not controllable by unit cost standards. Early budgets of overhead costs were valuable in determining costing rates but they had comparatively little value in the control of costs since they were of the fixed type. This shortcoming was met when flexible budgets were devised to measure performance in spending apart from cost fluctuations due to volume of work done.

With this background, it is seen that standard costs do not replace actual costs but instead they are a complement to actual costs. For some purposes historical costs are most useful, for other purposes predetermined costs are needed, and for still other purposes a comparison of the

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[3] George W. Lafferty, "The Auditor and Standard Costs," *N.A.C.A. Bulletin,* March 15, 1949, p. 820.

two serves management best. A complete plan of cost accounting thus includes both predetermined costs and historical costs. The choice lies not between standard costs and actual costs, but between standard costs and the less scientific estimates. Any disagreement is likely to relate to the extent to which predetermined costs are coordinated with actual costs rather than to the need for predetermined costs.

Many of the controversies over standard costs have their root in the different uses which are made of them. Costs prepared for one purpose are not necessarily appropriate for other purposes. Hence the study considered separately the application of standard costs for the purposes of cost control, inventory costing, budgetary planning, and pricing.

STANDARDS FOR COST CONTROL

Cost control presupposes a plan or program which is embodied in a set of standards specifying how each job is to be done and what it ought to cost to do it. The development of product specifications, operation methods, and operation times is a responsibility of the engineering or production division of the business; hence the control standards which are based upon production methods are established by the production division. Operation under the standards proceeds by comparing actual costs with the standard costs as the work is being done and by taking appropriate action to correct unfavorable variances as such variances occur. Corrective action to eliminate variance causes lies in the field of management, but operating management relies on the accountant for facts which make possible intelligent executive action toward control of costs.

STANDARDS SHOULD ANSWER QUESTIONS

Standards for cost control must provide answers to three questions, viz.,

1. For what should costs be incurred?
2. How much should the costs be?
3. Who is responsible for control of the costs?

Effective control requires detailed standards to show how much of each material should be used, how many hours of labor should be required for each operation, and what facilities and services should be needed. The number of separate standards required to give this detail is governed by the complexity of the manufacturing process, but in all cases the standards should tell exactly what should be used to accomplish the task. Control at the factory operation level is primarily a matter of controlling quantities and usage of material, labor, and services. For

the foremen and other employees who are directly in contact with the work it may be preferable to state both standards and variances in terms of physical units, i.e., in pounds of material, hours of labor, etc. However, when details are combined in summary form for the use of supervisors, it is necessary to state standards as dollar costs. Both actual and standard quantities are priced at standard rates in order to permit measurement of cost performance under quantity standards free from the influence of price changes.

In order that a standard may specify how much should be spent to accomplish a given task, it is necessary to determine first, the tightness with which a standard is to be set, and second, how the total amount spent should change with volume of work passing through the cost center. The tightness with which standards are set differs widely among users of standard costs. Standards in use were found to vary from those well above possible attainment down to those which were merely averages of uncontrolled past performance. However, a majority of the companies whose use of standard costs has been most successful set material usage and labor time standards to represent attainable good performance. Waste, spoilage, lost time, etc., are included in the standards to the extent that management considers it impractical to eliminate them during the time the standard is to be in effect. Such standards can be met or even bettered, but only by efficient performance.

Direct labor and direct material cost varies proportionately with the number of units produced and hence direct costs are controlled with unit standards. On the other hand, indirect costs cannot be controlled with standards in unit form because the average overhead per unit varies as the volume of production increases or decreases. To meet this difficulty cost standards used to control indirect costs are set in the form of flexible budgets which give the total amount of cost which should be incurred at the actual level of activity.

MATERIAL AND LABOR RATE STANDARDS

Material price and labor rate standards are useful in cost control primarily because they make it possible to separate cost variances arising from controllable conditions from cost variances caused by changes in prices and wage rates over which there is usually little direct managerial control. Inventory costing considerations appear to be more important than cost control in setting price standards, a fact which seems to explain the general practice of setting price standards to represent current or expected actual prices rather than efficient or desired prices.

Control standards must be kept up to date if they are to be accurate measures of the efficiency with which work is being performed. Hence

standards are usually revised when important changes take place in methods of production, labor efficiency, or material specifications. Changes in price have no effect on the control of operating efficiency in the plant and they are more commonly revised on an annual basis.

STANDARDS SHOULD BE KNOWN

The study shows that control is most effective when standards are set in terms of personal responsibility for each cost incurred and actual results are then measured against the respective standards in order that each individual may know how his performance compares with that which was expected of him. Timing is also important, for the effect which standard costs can have in controlling costs must come before or at the time the costs are incurred. Thus the person responsible for a cost should know the standard in advance and any variances should be reported to him promptly. Use of numerous variance accounts was found uncommon, for control of costs at the source is best attained by frequent and sometimes informal reports prepared directly from underlying records such as material requisitions, time cards, scrap and spoilage reports, etc. Reports drawn from the accounts usually arrive too long after the fact to be of much value for cost control and hence variance detail in the accounts is limited to information needed for disposal of the variance balances at the end of the period.

Usefulness in aiding cost control was found to be a major reason for employing standard costs, although there was wide variation in the success with which this aim had been achieved by the various companies. The following interesting observations were made with respect to conditions which accompany successful use of standard costs for cost control:

1. Management is interested in controlling costs, is aware of the advantages offered by standard costs for this purpose, and uses the variance reports.
2. Standards are reliable, current, and represent good but attainable performance. Management and operating personnel both have confidence in the correctness and fairness of the standards.
3. Reports are prepared which keep management at all levels informed of progress relative to standards.
4. The system of record keeping is simple.

On the other hand, conditions which stand in the way of successful use of standard costs for cost control are:

1. Management is unaware of the usefulness of standard costs. For this reason several companies having well-developed standard cost plans for product costing make little use of their standard costs for control purposes.
2. Standards are out-of-date, unreliable, or are designed to give product costs rather than operation costs. As a result of the first two conditions the standards are not taken seriously. The result of the latter condition is that

variances cannot be traced to their sources without laborious investigation or are determined too late to be of interest.

3. Reports are not prepared in terms which management understands. Executives with a production or sales background may not be able to interpret accounting terminology.

Several factors sometimes mentioned as determining the success with which standard costs can be used did not appear to be significant. These are:

1. The nature of the processes used or the products made. Companies were found using standard costs successfully in simple process type industries, in industries carrying on mass production of standard products of many types, and in job order industries where production was complicated and products built to special order. However, it was evident that the specific plan of using standard costs must be adapted to the needs of the company.
2. Size of the company. When a company is large enough to need records and reports to keep management in touch with operations, standard costs seem applicable.
3. Rapidly changing conditions of the postwar period. It seems that more frequent revision of standards is necessary, but effective use of standards was seen to be possible.
4. Cost of operating the standard cost plan. Standard costs usually reduce bookkeeping expense. In a few cases standard costs were stated to be more expensive than a costing plan without standard costs because a more highly skilled staff is required, but the results obtained were viewed as ample to justify the expense incurred.

STANDARD COSTS FOR COSTING INVENTORIES

While standard costs need not be entered in the accounts in order to use them for purposes of cost control, pricing, or budgeting, their incorporation into the accounts both facilitates the process of accounting for costs and strengthens the effectiveness with which standards can be used for other purposes. In the present study it was found that all but four of the seventy-two companies had their standard costs entered on their books.

By use of standard costs, bookkeeping can be simplified, clerical expense reduced, and reports prepared more promptly. These advantages result from eliminating the need for carrying many variations in actual costs through the inventory accounts. When standard costs are used in accounting for costs, fluctuations in actual cost are diverted to variance accounts, accumulated there, and disposed of in total instead of being spread over numerous processes or orders. The specific methods of accounting used with standard costs were found to be highly varied. It is not possible to say that one of these methods is better than another, for that method seems best for each company which is best adapted to its operations and general plan of accounting.

HANDLING OF INVENTORIES

In determining the periodic income, the cost assigned to raw material, goods in process, and finished goods inventories is of prime importance. There exists a divergence of opinion as to whether or not standard costs are proper costs for this purpose. Whether inventories are costed at standard or at approximate actual cost by companies using standard costs appears to be determined largely by:

1. The type of standards employed. When standards are current most companies charge off the variances in the period in which they are developed and cost inventories at standard cost.
2. The degree of success which the company has in keeping over-all actual costs in line with standards. Large net variance balances, especially those arising from changes in material price and labor rates, are commonly divided between inventories and cost of sales.
3. The concept held with regard to the kind of cost most suitable for costing inventories. A few companies were found to prefer actual costs for inventories even when variances are insignificant.

A majority of the seventy-two companies state their inventories at standard cost and charge the variances against income of the period in which the variances arise. They justify this practice on the ground that variances represent inefficiency, avoidable waste not recoverable in selling price, and random fluctuations in actual cost. As such, these variances are treated as period costs rather than as costs of goods in inventories. This reasoning requires standards which are current and attainable. Changes in external factors, such as prices or changes in methods and performance efficiency which are made or accepted by management, require revision of standards used in costing. These revisions are generally made during the latter part of the fiscal year. When the conditions which resulted in a revision of standards have affected inventories on hand at the closing date, these inventories are stated at new standard cost.

Standards which are not current still may have value in reducing the clerical expense of bookkeeping for costs. However, in this case the general practice is to divide the variances between inventories and cost of goods sold thereby converting both inventories and cost of sales to approximate actual cost.

STANDARD COSTS FOR PRICING AND BUDGETING

In order to set selling prices, executives who make pricing decisions need information about the relevant factors, one of which is cost to make the goods to be sold. Standard costs are considered especially valuable for pricing because they are based upon a careful study of what can be accomplished with the production facilities available, and they are costs which can be readily adjusted to reflect anticipated changes in prices

of material and labor. The extent to which such adjustments are made by the companies interviewed was found to depend upon the nature of the standards employed by each company. When standards have been recently revised to reflect performance which the company expects to attain and prices which it expects to pay for material, labor and services, standard costs are used for pricing without adjustment. On the other hand, where anticipated changes in costs are not already incorporated in the standard costs or where standards do not cover all the costs which the company expects to incur to produce the goods, standards are adjusted accordingly. An average allowance for expected variances is commonly incorporated in costs used for pricing purposes even when such variances are excluded from inventories in accounting.

Standard costs are used in budgeting primarily for determining the cost to manufacture the goods called for by the budget plan. Used for this purpose they provide a ready means for translating the budgeted production figures into manufacturing costs. Standard costs would seem to give more reliable results for this purpose than estimated costs or past experience because standard costs are based upon careful studies of material-usage requirements, operation methods and times, variability of cost with volume of production and the best arrangement of available equipment. It is usually necessary to include a forecast of variances from standard costs in the planning budget. By making such a forecast of variances, the standard costs can be used in building up the cost figures called for by the budget and then adjusted in total by the amount of the variances predicted. In those cases where no forecast of variances is made, the standard costs are revised to incorporate in them the conditions which would otherwise produce variances.

COORDINATING THE USES OF STANDARD COSTS

The study shows that standard costs need to be reasonably current at all times when used for cost control. Hence changes in control standards are made more or less continuously. However, for reasons of clerical economy these interim changes are usually made only in the detailed operation standards. They are not carried all the way through to the standard cost of the finished product until the end of the year when product costs are needed for inventory valuation. Variances between control standards and product costing standards are written off during the interim periods. Adjustments of various kinds are also commonly applied to the costing and control standards before standard costs are used in pricing and budgeting. These adjustments are made statistically rather than entered on the books.

As a final observation, the survey of seventy-two individual standard cost systems showed that a substantial number of these companies are

not making full use of the potential which standard costs have. Thus there are companies which use their standards for bookkeeping purposes but make practically no use of them for the purpose of cost control. Other companies do exactly the opposite. In somes cases the factory and the accounting department each has its own set of standards. There are also companies with standard costs which have been carefully developed for pricing, but which are not used to help keep actual production costs in line with the costs on which prices are based. On the other hand, some companies have carefully integrated and complete plans whereby they use their standards for all of the purposes which have been described. It would seem that these are the companies which are really getting the maximum of benefits from their standards.

47. THE COST ELEMENT IN PRICING

Clarence B. Nickerson*

The statement that costs determine selling prices is critically reviewed by the author without summarily rejecting the proposition that the statement is false. The limitation of cost information and the difficulty of cost ascertainment are among the problems discussed.

The pressure of new problems arising under constantly changing conditions reduces the time available to the businessman for the consideration of perennial problems. The latter type, though less pressing, has a vital bearing on the long-run success of an enterprise and merits periodic review. It was with this in mind that the present consideration of the relationship of costs and selling prices was written.

Questions concerning this relationship constitute a perennial problem of varying intensity. At intervals throughout business history the problem has become acute for a large part of the business community, as it was, for example, under the National Recovery Act, and as it is under the Robinson-Patman Act. For the individual enterprise the problem has varied in importance under changing business conditions, including both short-run and long-run shifts in demand and supply, the introduction of new products, the use of new materials and methods of production,

* From *Harvard Business Review*, XVIII, 4 (1940), 417-28. Reprinted by permission of the *Harvard Business Review*.

and the increase or decrease in costs of operation, including distribution costs.

Going well back to an earlier day we find Adam Smith speaking of the "natural price" of a commodity, which, briefly, is a price that is neither more nor less than sufficient to cover "ordinary or average rates" of ". . . wages, profit, and rent, at the time and place in which they commonly prevail."

He recognized that the actual price at which a commodity would be sold, called the market price, might ". . . either be above, or below, or exactly the same with its natural price." He said, "The market price of every particular commodity is regulated by the proportion between the quantity which is actually brought to market, and the demand of those who are willing to pay the natural price of the commodity, or the whole value of the rent, labour, and profit, which must be paid to bring it thither."

Referring again to his "natural price," he stated, "Though the [natural] price . . . is not always the lowest at which a dealer may sometimes sell his goods, it is the lowest at which he is likely to sell them for any considerable length of time; at least where there is perfect liberty, or where he may change his trade as often as he pleases."[1]

Not all of these ideas are in acceptance today, but they have developed into the general proposition that selling price must cover cost in the long run if the supply of a product is to be maintained. There is considerable disagreement as to the meaning of cost, and inasmuch as the cost of a product is the result of a great many factors, including judgment and opinion, it is likely that there will always be disagreement as to its meaning.

Whatever may be the exact meaning of cost, cost and supply are Siamese twins, and if in the long run the cost is not covered by selling price, the supply will die from lack of nourishment. The pressure from various sources which forces downward revisions of prices can be relieved by reductions in cost, but if the pressure over a long period is such that successive reductions in cost are inadequate to meet it, then supply will be decreased through voluntary reduction in output, voluntary transfer of capital to the production of other goods, or through the failure or bankruptcy of the less efficient or financially weaker producers.

The most important relationship of cost and selling price is that the cost at any given time represents a resistance point to the lowering of price. In time, if reductions in cost do not keep pace with reductions in selling price, the supply of the given commodity will be reduced. In

[1] Adam Smith, *The Wealth of Nations,* Book I, Chap. VII.

the long run those who wish to be supplied with the commodity must pay a price that will cover cost, including a reasonable margin of profit if the supply is to be kept healthy.

WHOSE COSTS HAVE THE MOST EFFECT ON SELLING PRICE?

As a practical business matter we know that at any given time within an industry there are marked differences in cost as between one producer and another. We may then well inquire as to whose costs will have the most effect on selling prices in the long run?

In the extractive industries such as mining and agriculture, the costs of the marginal producers have the greatest influence on price in the long run. Nature has caused permanently different costs as between producers. Under these conditions, as Taussig has said:

> The point about which oscillations range and to which price tends to conform is cost for the least advantageous producer. Without him, the total supply cannot be enlarged to the point at which there is an equilibrium of normal supply and demand. If indeed there were no limit to the amount which the more advantageous producers could bring to market—if this fortunate set could increase the output indefinitely at constant cost—the marginal producer would be driven out, and the conditions would be those of constant cost. There being such a limit, he must be called on for the maintenance of supply, and there must be in the long run a price which will make it worth his while to contribute. Value is then determined by cost to the marginal producer; but at what point in the varying scale of costs that producer will be, depends on the conditions of demand.[2]

In manufacturing industries, on the other hand, differences in cost as between one producer and another are not permanent. There is opportunity for the less efficient producer to improve his condition, and the more efficient producer of today may in one way or another lose his relative standing. The more efficient producers tend to displace those who are less efficient. Under these conditions it is the cost of production of the average company, in the sense of Marshall's "representative firm," which tends to have the most effect on selling price in the long run. He described such a firm as one

> . . . which has had a fairly long life, and fair success, which is managed with normal ability, and which has normal access to the economies, external and internal, which belong to that aggregate volume of production [the scale of production in the industry]; account being taken of the class of goods produced, the conditions of marketing them and the economic environment generally.[3]

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[2] F. W. Taussig, *Principles of Economics* (4th ed., New York: The Macmillan Company, 1939), Chap. 13, § 2.

[3] Alfred Marshall, *Principles of Economics* (8th ed., London, Macmillan and Co., 1920), Book IV, Chap. XIII, § 2.

Many businessmen fail to see anything of practical importance to them in the concept stated above of the long-run relationship of costs and selling prices. It is self-evident that a company cannot continue indefinitely to sell below cost. Executives of companies that are knowingly selling below cost hope that in the long run prices will improve or costs will be reduced. Barring these possibilities they hope to be able eventually to change the nature of their production, or if this is not feasible, to salvage all they can as long as something above out-of-pocket expenses can be realized. In the meantime they are continually beset with immediate or short-run problems that absorb their time and effort and even cast a short-run shadow on their long-run thinking.

LACK OF COST AND SELLING PRICE RELATIONSHIP WHEN COSTS ARE UNKNOWN

One matter of practical importance is that except over an extremely long period cost does not offer an effective resistance to the lowering of price in an industry in which the average company has little or no knowledge of its costs. In such industries it is common for businessmen to say that selling price is based solely on market conditions, meaning that costs have little or nothing to do with selling prices. It is not far from the truth, however, to say that selling prices in these industries are based on lack of intelligence. Under such conditions it is extremely difficult for even capable executives who know their costs to operate at a profit.

The shoe industry, for example, has suffered from a number of ills, not the least of which has been the lack of knowledge of costs. Owners of small job printing plants, small trucking concerns, and garages are notoriously unaware of the cost of doing business, and the list might be extended to cover a number of other industries. Many companies in such industries are not operating as going concerns but are merely passing through orderly liquidation without realizing it. When these companies fail, it is the owners who fail, but the properties are usually sold to newcomers who continue the process of liquidation, often temporarily enjoying a profit because of the relatively low investment cost at which they entered business. Not infrequently these newcomers cut selling prices because of their lower "costs" and thereby force competitors to join the spiral of liquidation. The textile industry, among others, has had quite a taste of this.

In summary at this point, cost offers a resistance to the lowering of selling price, and in the long run selling price must cover cost if those who wish a given commodity are to be supplied with it. Except over an extremely long period, cost offers no effective resistance to the lowering of selling price in industries in which the average producer has no knowledge of costs. Under these conditions, cost becomes effective

only after generations of people have lost their savings and the idea finally permeates that it does not pay to invest in these industries.

PRICE DEPENDS UPON BOTH DEMAND AND SUPPLY

Depression conditions, and the spirit of defeatism arising therefrom, have strengthened the popular belief that selling prices are based on market and bear no relation to cost. This belief overlooks the fact that it takes both demand and supply to make a market, and broadly speaking the supply side when expressed in dollars is the cost of production and distribution. For every purchase there must be a sale, and price takes into account the interests of both buyers and sellers, though at any given time the interests of one group will be dominant.

In dealing with the influence of both demand and supply on price, Marshall likened demand and supply to the two blades of a pair of scissors. He said, "We might as reasonably dispute whether it is the upper or the under blade of a pair of scissors that cuts a piece of paper, as whether value is governed by utility or cost of production."[4] At any given time one blade may seem more active than the other, but it takes both blades to do the cutting. Cost then offers a resistance to the lowering of selling price not only in the long run but also in the short run, though the effectiveness of this resistance is subject to considerable variation, and tends to increase with the increase of the period under consideration.

DIFFERENCES BETWEEN INDUSTRIES IN THE RELATION OF COSTS AND SELLING PRICES

In some industries cost offers a more effective resistance to the lowering of selling price than it does in others. Industries have been mentioned above in which the lack of knowledge of costs does not give cost a chance to act as an effective resistance.

In contrast, the steel industry is led by large companies in which cost accounting as an aid both in managerial control and in price policy has been developed to a high degree. These companies tend to restrict production when selling prices do not bear a satisfactory relationship to costs, and the withdrawal of supply tends to correct the condition. It is evident, however, that under depression conditions these tendencies have weakened.

There are certain industries in which the products have a high degree of uniformity and in which the manufacturing costs tend to be uniform, as in the production of staple commodities, such as flour, sugar,

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[4] Alfred Marshall, *op. cit.*, Book V, Chap. III, § 7.

and certain types of textiles. Here the relationship of cost and selling price is very close. As Taussig has said, "Those staple articles which are used regularly from year to year in much the same quantities are sold at prices which are surprisingly close to constant (i.e., uniform) costs."[5]

Custom has established fixed prices for certain products, for example, cigars at 5 cents, 10 cents, 15 cents, and two for a quarter, which bear no relation to cost, at least in the short run. From time to time there will be slight changes in prices charged to wholesalers and retailers but these are more likely to be motivated by price wars between manufacturers than by changes in cost. Over a long period the quality of the product is likely to change, representing an adjustment of cost to the fixed selling price. In this sense there is here a long-run relationship between cost and selling price.

For some years now there has been an increase in the number of consumers' goods sold at fixed prices, fixed in the sense of single prices advertised by the retailer over quite a period of time, as distinct from minimum retail prices suggested by manufacturers. Such prices are not so difficult to change as are prices for goods that are based on the denomination of coins, but they do set up rigidities in the price structure and delay the adjustment of selling prices to changes in cost, particularly when raw material prices are rising. Though adjustments can be made in the quality of the goods sold at the single price, they must be made very cautiously if customer goodwill is to be retained.

There are some consumers' goods not advertised at fixed prices but for which the consumer has become accustomed to paying a certain price, and on which minor changes in quality can be made without unfavorable consumer reaction. Shirts and neckties, at least those on which the quality has not been highly advertised, are in this class of goods.

In the textile industry, it is commonly said that market sets the price. It would be unrealistic, however, to deny that price at least takes into account the available supply, or current cost, of raw material. Furthermore, manufacturers will do what they can to adjust the raw material content and structure of the cloth to bring down the cost so that a profit can be realized at the given market price. Thus though we can say here that the price is set by the market, it is not correct to say that this price is devoid of any relationships to cost. Cost may not directly determine the price, but in this case it tends either to discourage production on the part of those who cannot cover their costs under the given price, or to determine the quality that can be produced for the given price.

[5] F. W. Taussig, *op. cit.*, Chap. 12, § 4.

Thus far we have been considering cost in general terms, and certain fundamentals with respect to the relationship of cost and selling prices, particularly in their long-run aspects, and in certain selected industries. Let us now examine the type of cost knowledge available to an individual manufacturing company, say one of Marshall's representative firms, with respect to its relationship to prices and effect on pricing.

HISTORICAL PRODUCT COSTS

Part of the work of the cost accountant involves ascertaining and recording the costs of products manufactured. Many believe that this is all that a cost accountant does, but while this task may occupy the full time of several people, it is by no means the only duty of the cost accounting department. Though the cost accountant gathers historical records of cost for the books of account, and in particular for the valuation of inventories and for the determination of cost of goods sold, and though he supplies management with cost figures of one sort or another to be used as an aid in pricing, his chief function is to supply management with cost information and standards of measurement as an aid in controlling the operations of the business.

Product costs gathered currently by the cost department are not of immediate aid in pricing, nor do current prices necessarily bear any relationship to them. The actual material, labor, and overhead costs of products as gathered on cost sheets are subject to temporary fluctuations through changes in price and variations in yield of material; through changes in labor rates and efficiency; through price variances in certain types of overhead and differences of efficiency in the utilization of plant and equipment; and through variations in the volume of operations.

Accounting figures are a blessing in that they provide a means of expressing the ebb and flow of a business. They are a curse in that they imply an air of accuracy and finality that is misleading. The historical cost of any product involves cost allocations based on judgment, opinion, and custom, and is subject to the variations mentioned in the previous paragraph. Over a period of time a body of cost information can be built up so that it is possible to develop average product costs that may be of help in pricing, particularly where prices have to be set that will be maintained for some time in the future, but the current cost of a product should not be taken literally for current pricing purposes.

This statement does not mean that the current unit product cost should be ignored; it should be compared with the current selling price of the unit as one measure of the profitability of current operations. If the profit margin is below normal, management may thereby be stimulated to seek cost reductions, greater volume, or better prices. Needless to

say, there are many other factors besides current unit product costs and current selling prices to be considered in executive action aimed at improving the profit situation. Two of these factors, for example, are the current volume of sales and the selling costs by types of product. Some executives have been known to think of the profitability of a given product only in terms of its gross profit per unit. The failure to take into account the volume of sales and the selling costs of each type of product is very dangerous. Not long ago a manufacturer with whom I am acquainted proposed that great effort should be expended to obtain more sales of one of his company's products on which the per unit gross profit was comparatively high. The facts were that this product had very limited uses and a salesman who concentrated his efforts on selling it would not be likely to obtain more than a five dollar order for it per day. If any shift in sales effort was called for, it was toward concentration on items that showed a relatively low per unit gross profit but also had a low per unit selling cost and relatively large volume of sales, and made the greatest contribution to the net profit of the business.

STANDARD PRODUCT COSTS

As was stated above, an averaging of actual unit product costs over a period may be undertaken to remove the purely temporary cost fluctuations and provide management with a more accurate picture of product costs. The same thing has been accomplished by many companies through the development of standard costs. Standard costs have been used primarily as the basis of a technique for control over costs, but they have also provided many executives with a foundation of cost knowledge, which when used with caution and common sense has been helpful as one aspect in pricing.

Sometimes businessmen when supplied with standard costs are inclined to accept them too literally. I recall an executive who, after considerable persuasion on the part of accounting consultants, adopted standard costs. A file of standard costs per unit of each product manufactured was developed as part of the system, and it taxed the powers of persuasion of the consultants to the limit to prevent the executive from drafting these costs bodily into his price policy and from refusing ever to sell at prices that were below them.

In some companies standards underlying the standard product costs are so set as to constitute goals for attainment that are beyond normal expectations. While this may be satisfactory for operating and control purposes in some companies, the standard product costs developed by the use of such standards are too low to be used as a satisfactory basis for the cost side of price considerations. Standards based on good average performance are more satisfactory for the latter purpose.

Standard costs are commonly adjusted at the outset of a new manufacturing season, which in many companies means that they are revised twice each year. In some companies they are adjusted at more frequent intervals in accordance with significant changes in raw material prices, or labor rates, or with significant changes in overhead costs, or volume of operations.

If standard costs are to be used in price considerations in industries in which finished goods prices tend to fluctuate with raw material prices, they should of course be adjusted with changes in raw material prices if they are to be of practical value, since the replacement cost of the raw material at the time a price is quoted for a product is of greater significance to the price than an average cost would be; in fact it is of greater significance to price than is the actual cost of the raw material that will be used to make it.

With respect to the overhead cost element in standard costs, practice varies between companies as to the volume of operations assumed in determining standard overhead rates, upon which in turn, standard product overhead costs are based. The major difference is that some companies base their rates on costs and volume expected in the coming period, while others use the costs and volume expected under normal conditions.

An executive, whose company uses the volume expected in the coming period in determining standard overhead rates, told me, "We do not fool ourselves by using an arbitrary normal volume. What we are after is representative actual costs." An executive in another company, who believes in loading costs in accordance with what the traffic will bear, expressed quite the opposite objection to the use of a normal volume by saying, "When business is good, the overhead costs (of products) based on normal volume are not high enough, and when business is poor they are too high." The latter executive would have to admit, however, that as volume rose above normal, the standard product cost derived from rates based on normal volume would be higher than the actual cost per unit of product (because the actual cost would involve the division of fixed charges by a greater number of units of product); and, conversely, as volume fell below normal the standard product cost based on a normal volume would be lower than the actual cost per unit of product. The same would be true in a comparison between standard product costs developed from rates based on volume expected in the coming period and standard product costs developed from rates based on normal volume.

While psychological or operating benefits on the one hand and financial expediency on the other may validate the opinions expressed by these gentlemen, it seems to me that the use of normal volume is more

helpful in price considerations. The least that can be said is that standard overhead product cost based on normal volume provides management with a workable concept of one element of long-run cost that it should seek to recover in the selling price in the long run.

SUMMARY ON ACTUAL COSTS AND STANDARD COSTS

In summary, with respect to the actual costs of products gathered by the cost accounting department, such costs are only indirectly of aid in pricing and bear no necessary relationship to current selling prices. Standard product costs adjusted in accordance with significant changes in raw material prices and labor rates, and with overhead derived from rates based on the normal volume of operations, are more helpful in pricing than are actual product costs. Standard product costs or a body of actual product costs gathered over a period and used in conjunction with supplementary information, or the two together, are of aid in determining the profitability of each type of product manufactured, prevent management from unwittingly selling below cost, serve as a resistance to the lowering of selling price, and stimulate efforts toward cost reduction, improved sales volume, and better prices. This cost information compared, where possible, with the costs of other companies provides an individual concern with information on one aspect of its relative position in the industry, which is an important factor in price policy. It is understandable that most companies are not charitable with respect to releasing cost data, and unless figures have been gathered by a trade association or research bureau, the relative position of a company with respect to costs of production can only be determined in a roundabout fashion by taking whatever information is available and filling in the missing links by conjecture and deduction.

SPECIAL COST STUDIES ON NEW PRODUCTS

In pricing a new product it is desirable to estimate its costs under various volumes of production (basing this, insofar as is practicable, on records of previous experience with respect to the operations through which the new product will pass), and to compare these costs with estimates of expected receipts from various volumes of sales at assumed selling prices; the object being to arrive at an attainable volume of production and sales that will bring in the largest total net receipts. In the classroom it is a simple matter to assume a demand curve and a supply curve to arrive at a theoretically desirable price. In practice, it is very difficult to develop for a new product either a demand curve or a supply curve that can be accepted with confidence. The cost accountant knows well the difficulties of determining the cost of existing products at

existing volumes, let alone the difficulties of predetermining the cost of a proposed product at proposed volumes of production. With respect to demand, it takes a combination of judgment based on experience, deduction based on tests or on the apparent experience of others now in the market with products of a similar type or class, intuition, imagination, and crystal gazing to estimate what the demand for a new product will be at various prices. For that matter, it is not a simple problem to estimate the future demand for a product that is already on the market and on which a price has been established. To date, though great strides have been made in the techniques of forecasting demand, it is still, particularly because of changing conditions and because of the human factors involved, much more of an art than it is a science.

One way of looking at the cost of a new product is to consider as the cost only the additional expenses involved in producing it. Cost would then be composed of the cost of raw material and labor expended on the product, the variable overhead expense that would not have been incurred had the product not been taken on, the fixed charges on any new plant or equipment purchased to produce the product, and any additional selling expense involved. As a refinement we might add to this interest on the capital required to finance the production and sale of the product, provided that the same capital could otherwise be employed elsewhere.

If the possible increment receipts from sales exceeded this increment cost, it is evident that insofar as these factors are concerned, the company would be better off to produce and sell the new product than it would be not to do so. Regardless of how one might feel about computing cost in this manner, it does set a rock bottom to the selling price that can be accepted without incurring an immediate out-of-pocket loss.

One of the dangers of placing too great emphasis on costs solely in terms of the additional costs involved in producing a new product is that management may be moved to set selling prices lower than is necessary under the actual conditions of demand. If the demand could be ascertained with accuracy, there would be little danger of this, but in most cases estimates of demand are not too reliable and the temptation is to take the defensive and to quote prices that are lower than warranted.

Carelessness in placing too great emphasis on increment costs in pricing a new product may hurt a company by spoiling the market for future sales, and by causing unfavorable reactions of other producers. An extreme example of the latter situation is when one company enters the field of another company by selling a new product priced slightly above increment cost, whereupon the second company retaliates by entering the field of the first company with a new product also priced

on an increment cost basis, and both companies find themselves worse off than they were before the whole thing started.

If we propose to take on a new product for a short time to make use of idle capacity, or to provide work for employees, and if we can see no danger of repercussions, the additional costs involved in producing the product will be the most helpful type of cost analysis. This might also be the case if the proposed new product is needed to fill out our line largely as a service to customers. This type of analysis, coupled with demand analysis, would also be most helpful if we can shift readily from one type of product to another and are trying each year, or each selling season, to maximize our profits.

If we are contemplating bringing out a product that is new to us but that is already being produced by others in a highly competitive market, it is likely that we will have to accept the market price as given and study our costs to see whether or not we can enter the market and realize anything above them. If we intend to enter the market for a short time only, and can foresee no unfortunate repercussions, the additional costs involved will be the major cost consideration. If we intend to stay in the market and have the new product become one of our major products, short-run cost considerations will not be enough. In other words, if the new product is to become a member of the family, it should take up a fair share of cost and profit responsibility.

In bringing out a new patented product that is not now on the market, the major consideration is the probable price people will be willing to pay for it and cost is a minor factor. With the passing of time, changes take place causing a narrowing of the margin of profit and the development of a relationship of selling price and cost, at least in the sense that cost offers a resistance to the lowering of selling price. In the old age of the product the selling price may have been worked down until it covers, with little or no margin, only the additional costs incurred in producing it, though it is possible in some cases that, by this time, the demand may be restricted to a relatively few consumers who are attached to the product for one reason or another and are willing to pay a good price to obtain it. In industries of this type profitable operation depends upon the maintenance of a healthy average age of products by the periodic development of new products to take up the cost and profit responsibilities that can no longer be borne by products reaching old age.

RELATIONSHIP OF VOLUME, COST, AND SELLING PRICE

Businessmen are often tempted to reduce prices on existing products in an effort to increase volume, the aim being to spread fixed costs over a larger volume of production and thereby more than make up for loss

in price. The concept not only involves a careful estimate of the extent to which demand can be increased by a given decrease in price, but also a careful estimate of what the costs will be under the increased volume. Such studies often reveal that it will take a considerable increase in volume to make up for the loss in price, and this statement of course is especially true where variable costs constitute a large portion of the total cost of a product. On the other hand, the results from lowering price have in many cases been far more beneficial than was anticipated. Not infrequently management has found to its surprise that a net benefit has been received from a reduction in price even though the reduction may have been forced by competitive conditions. Both short-run and long-run considerations are involved in any reduction in price, including the possibility of spoiling the market and the probable action of competitors if prices are lowered.

Earlier in this paper, mention was made of actual product costs as compiled in the cost records, and of standard costs based on a normal volume of production. It is also desirable for control purposes, and for planning operations and financing, to know the costs (i.e., costs by items, as distinct from product costs) at various volumes of operation. This is of particular importance with respect to variable overhead costs. At the present time many of the leading concerns in all types of industry are developing variable budgets in connection with studies of costs under varying volumes of operation, and such studies and budgets related to financial results are indirectly of aid in pricing.

48. ORGANIZATIONAL STRUCTURE AND PRICING BEHAVIOR IN AN OLIGOPOLISTIC MARKET

R. M. Cyert and J. G. March*

In this article the authors explore the proposition that organization theory can aid in the understanding of organization behavior, particularly price behavior under oligopolistic conditions.

One of the most common propositions in the literature of organization theory is that a change in organizational structure results in a change in operative organization goals. To the extent that this is true, it should be

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possible to develop a model that specifies a meaningful relationship between significant characteristics of organizational structure and some important attributes of organizational behavior.

The theory of price determination in an oligopolistic market situation is generally unsatisfactory to economists. Typically, neither the level of price nor price changes can be explained. The tendency of oligopolistic firms to change price relatively infrequently in comparison with firms in competitive markets has frequently been noted. While it is not maintained here that organization theory can provide the whole, or even the major answer, it is the purpose of this paper to indicate some of the ways in which such theory can be brought to bear on the problem of the price behavior of a firm in an oligopoly market.

Since "organizational structure" and "price behavior" are ambiguous terms, they are defined in Section I. In addition, the development of the model requires the specification of a series of functional relations between organizational features and pricing behavior. This is done in Section II.

I. DEFINITION OF VARIABLES

The approach taken here should not be viewed as challenging the basic variables that have been treated as price determinants in economic theory. For firms operating in a perfectly competitive market, for example, nothing discussed in this paper has much relevance. The position taken is that the firm's perception of the market and the firm's perception of its capabilities for action are both affected by its own organizational structure. Given significantly different organizational structures, two firms facing the same external market and using the same set of variables in decision-making will exhibit substantial differences in price behavior.

Price behavior is defined in terms of three characteristics: (1) frequency of price change is measured as the number of changes per time unit;[1] (2) magnitude of price change is measured for any given change by the ratio of the amount of change (*i.e.*, the absolute difference between the old and the new prices) to the old price; (3) direction of price change can be positive or negative, measured with respect to the last previous price.

Organization structure is defined in terms of two characteristics:

1. The communication pattern of the organization. Pricing decisions are assumed to be based upon expectations concerning future sales, costs, and competitors' behavior. One of the functions of the organization of

[1] In the present analysis, the primary interest is in the organizational effect on price behavior of firms operating in the same market. The restriction to firms operating in the same market is made in order to hold constant the restraints imposed by market forces upon the frequency of price changes. Since the stringency of such restraints varies from one market to another, a comparison across markets of the organizational effect upon frequency of price change could not be made without the introduction of some concept of "opportunities for change."

the firm is to provide information upon which such expectations can be based, and the design of informational channels by means of which such information reaches the decision-makers comprises the communication pattern of the firm.

Primary interest is in the relay points in a communication chain. A relay point is a "message center" which receives, decodes, encodes, and then retransmits an item of information. Relay points can be distinguished by the number of major variables (*e.g.*, cost) about which they transmit information. This distinction is hypothesized to have important consequences for the amount of bias introduced at a particular relay point. Bias is defined to occur if any information is eliminated, modified, or added before a message is retransmitted. The character of control over a relay point is hypothesized to be decisive for the direction of the bias introduced, as is indicated more explicitly below.

The communication pattern of the organization is described by the nature of four different communication chains within the organization: the communication chains for demand information, for cost information, for information on competitors' behavior, and for information on firm policy. The nature of a given communication chain is determined by (a) the number of relay points in the chain, (b) their character, and (c) their order. The number of relay points in a communication chain is represented by a non-negative integer. The character of a relay point is determined by the type of information transmitted through it. If a relay point transmits only one type of information, it is defined to have the characteristic of that information. If information relating to more than one variable is transmitted by a relay point, the character of the relay point is determined by the relative frequency over time of incoming communications concerning the different variables. Thus, if most of the messages received relate to cost information, the relay point is considered to be a "cost" relay. The ordering of relay points is specified to distinguish, for example, a communication chain for competitors' behavior in which information on competitors passes through a "demand" relay point and subsequently through a "cost" relay prior to reaching the decision-making unit from a similar chain in which the ordering of "cost" and "demand" relay points is reversed.

2. The size of the decision-making unit in the organization is measured by the number of individuals in the decision-making unit for each of whom it is correct to say that there is no more influential person in the unit. Thus, if the decision-making unit for a pricing decision is a committee of four in which two committee members are dominant over the other two but equal in power with respect to each other, the size of the decision-making unit is 2. The problem of identifying the distinguishing power differentials within the formal decision-making unit is susceptible

to solution by the application of social-psychological techniques of influence measurement to the decision-making activities of the unit under investigation. For example, one method for defining power relations that has been used successfully consists in an analysis of the remarks made during decision-making conferences. The variable, therefore, is operationally defined although one should not expect the analysis in any given case to be simple. Under certain conditions, distinctive pricing consequences are seen as arising from critical differences in the size of the decision-making unit. These hypotheses are found below.

II. FUNCTIONAL RELATIONS

Demand, cost, and competitors' behavior have been the standard variables of most oligopoly models since Cournot. This paper makes no attempt to deviate from that tradition. On the contrary, the goal is to augment oligopoly theory by introducing into it some fundamental propositions of the theory of organizational behavior. Two modifications of traditional oligopoly models are suggested by such theory. The first is recognition of the fact that the values of the relevant variables actually used within the firm for establishing price are functions both of data drawn from the real world and of the organizational structure through which those data are transmitted to the decision-making unit; the second is similar recognition of the fact that the method by which perceived information on the relevant variables is translated into pricing decisions is a function of the decision-making unit's perception of, and adherence to, official firm policy.

Official firm policy, in the sense in which it is used here, consists in a specific set of constraints placed by the holders of legitimate authority in the firm upon the pursuit of organizational goals by their subordinates. A series of hypotheses with respect to the relative dependence of a pricing decision upon official firm policy, given the size of the decision-making unit, is made. The mechanisms involved are also specified.

1. Decisions by a group will, in general, be more dependent upon firm policy than will decisions by an individual. The proposition is deduced from the theory of group norms and reference-group behavior.[2] There is a reasonable amount of evidence to support the prediction that an individual with an attitude at variance with his perception of the group's attitude will tend (according to the relevance of the group for the satisfaction of individual goals) to adjust his "public" position to conform to the position he expects the group to take. Such behavior may be exhibited even in the limiting case where all members hold a position at variance

[2] A reference group for a given individual consists in those other individuals with whom he perceives himself sharing common evaluative criteria for judging an attitudinal position. The literature on reference-group theory is fairly extensive.

with their common perceptions of the group standard. Thus, even if every member of the decision-making group is "cost-minded," if each believes all of the others to be "sales-minded," the decision will tend to be a sales-minded one. Since in the absence of contradictory evidence, each member of the group can be assumed to believe all other members of the group to be in agreement with firm policy, the operation of group norms serves to enforce conformity to that policy.

From this it should be clear that when a relationship is predicted between the size of the decision-making unit and the extent to which decisions will be independent of official firm policy, the assumption is made that reference groups (*e.g.*, Board of Directors, professional associations) other than the pricing unit itself can be ignored. Such an assumption is based on a prediction that all decision-making units, whether composed of an individual or a group, will be subject to the same outside pressures; but only the members of a group unit will have the additional pressure of internal group norms.[3]

2. If a decision contrary to firm policy is reached by a decision-making unit, it will be more stable if made by a group than if made by an individual. This follows from the premises of the preceding hypothesis. A group provides the individual with a defense against outside pressures and simultaneously exerts a pressure toward intragroup conformity upon him. The group will ordinarily be less effective in enforcing a "revolutionary" decision than in enforcing an "ideologically sound" decision. This stems from the prediction that the latter type of decision will ordinarily create fewer cross-pressures than the former.

With respect to the communication-structure variable, two hypotheses of perceptual bias are made:

1. As the length of the communication chain is increased, factors are introduced that have the effect of inhibiting change. The temporal bias introduced by the change in conditions during the interval from the original transmission of the information to its final receipt by the decision-making unit is represented as a function of the number of relay points through which the information must pass. Clearly, this is only an approximation. The significance of variations in transmission speed among the relay points (*e.g.*, cost data travels more rapidly through cost channels than through demand channels) is neither denied nor introduced into the system, except implicitly in the statement of the second bias below.

The consequences of the temporal bias for the frequency of price adjustments stem both from the fact that one never "catches up" with

[3] Otherwise, it might be argued that where a pricing decision is made by a single individual, he will act with the originators of firm policy as a referent, and that, therefore, the test of the mechanism posited here would be vitiated by this restraint upon his "independence."

current information and also from the attempts of members of the organization to adjust for the bias by means of forecasts (*e.g.*, "What will the situation be by the time this information reaches the decision-maker?"). It is hypothesized that both major consequences of the time-lag in communication serve to introduce into the premiers of the pricing decision a bias against change. Note that this bias operates not only in the communication of, for example, cost information upward but also in the communication of firm-policy information downward.

2. The character of the communication chain introduces a bias into the information transmitted to the decision-making unit. The form of the bias is a tendency for a relay point to de-emphasize information inconsistent with the information with which it is primarily concerned. For example, let us make the assumption that the size of the market is consistently overestimated by sales departments and costs are consistently overestimated by accounting departments. Let us further assume that overestimation of demand results in an aggressive price policy (*i.e.*, frequent price changes, price-leadership), overestimation of cost in a passive price policy (*i.e.*, infrequent changes, price-following). Under these assumptions, the firm's reaction to the behavior of others will be related to the number of biasing relay points through which cost data must pass relative to the number for demand data. In particular, it is predicted that the communication of demand data through a cost relay point will tend to produce a passive price policy, and the communication of cost data through a demand relay point an aggressive price policy. Similar deductions can be made with reference to communications downward regarding firm policy.

If the organization is stable, it is expected that the biasing of information will be reinforced by a learning phenomenon, resulting in a gradual lowering of the level in the communication hierarchy at which consistently suppressed information is filtered out of the communicated message. Thus, for example, if a given relay point has been transmitting information on the potential market but finds that this information is never retransmitted by the next relay point, and if there are no alternative channels of communication, the transmission of information on the potential market will tend to cease at the lower level.

XIII

CONTROLLING PROFITABILITY

49. MEASURING THE PRODUCTIVITY OF CAPITAL

Joel Dean*

The management of a capital expenditures program is discussed on an over-all basis. The criteria for decisions and preparation of materials for making decisions are discussed.

The president of one of our largest oil companies, who was pushing through a program of drastic decentralization of management, stated recently that the last thing he would delegate would be decisions about capital expenditures. This is understandable because capital-expenditure decisions form the framework for a company's future development and are a major determinant of efficiency and competitive power. The wisdom of these corporate investment decisions, therefore, has a profound effect upon a company's future earnings and growth.

From the standpoint of the stockholder and of the consumer, capital expenditures are the principal bulwark against the seemingly endless progression of wage increases. From the standpoint of labor, capital expenditures are the basic economic source of future wage advances since they embody the creative forward strides of advancing technology. Finally,

* From *Harvard Business Review*, XXXII, 1 (1954), 120-30. Reprinted by permission of the *Harvard Business Review*.

capital expenditures, both by their aggregate size and by their cyclical timing, have a great deal to do with the character of the economy as a whole, and thus with the government's role in maintaining stability.

MANAGEMENT PROGRAM

Farsighted judgment is an essential requisite for wise decisions about capital expenditures. But such judgment, to be sound, must be based on analysis of all the facts, many of them extremely technical and complex. In particular, top management needs an objective means of measuring the economic worth of individual investment proposals in order to have a realistic basis for choosing among them and selecting those which will mean the most to the company's long-run prosperity. The basic measure of economic worth is the productivity of capital, which means its power to produce profits. The purpose of this article is to suggest better ways of making that measurement.

NEED FOR SPECIALIZED SKILLS

Unfortunately, the problem of managing capital expenditure has not generally been attacked with the kind of thorough and objective analysis that has paid such big dividends in other management areas. I have made a study of the capital-expenditure methods of some 50 large companies. These are all well-managed companies so far as production, engineering, and marketing methods are concerned, and I have a great deal of admiration for their executives. But on capital expenditures they show widespread failure to measure the investment worth of individual proposals directly, lack of defensible objective standards of an acceptable investment, and distorted dedication to procedures and paper work, with inadequate understanding of the economic content of the concepts used. In other words, when it comes to capital expenditures, they are still forced to play by ear to a distressing extent.

The development of an effective system for managing capital expenditures requires a complex combination of disciplines: (a) application of economic theory at several vital points; (b) knowledge of financial mathematics, which most of us acquired in our apprenticeship days but have inevitably forgotten long since; (c) economic forecasting; (d) techniques for projecting the amount and timing of outlays and receipts; and (e) techniques of control through comparison of actualities with projections. Top management clearly needs technical help. No executive, even if he had the time to analyze each capital proposal personally, could be expected to have all the necessary disciplines at his command; they can only be gathered together in a team of specialists.

TEN ELEMENTS

This article concentrates on the measurement of the economic worth of individual investment proposals. But we must remember that, though this is likely to be the critical element, it is only one of many components in a well-rounded program of capital management. EXHIBIT I, describing the ten components of a complete management program for capital expenditures may serve to put this particular element (No. 4 in the exhibit) in its operational setting.

ARE PROFITS CONTROLLING?

As we turn, now, to the phase of capital-expenditure management that is our main concern here—measurement of capital productivity—we must face an underlying question: To what degree are investment decisions actually controlled by profit considerations?

Concern with capital productivity of course implies that the company's goal is profits. But actually in many cases money making is a secondary objective. Often the primary goal is strategic—to maintain or increase the company's share of the market, to achieve growth in sales volume or number of employees, or simply to build reputation and status. Often capital expenditures capture and embody this kind of motivation in the form of corporate monuments made "just to become the kind of company we want to be." I am thinking of welfare and prestige investments like gymnasiums, country clubs, and palatial offices.

A corporation is not single-minded. It is composed of groups and individuals whose interests conflict. The concept of management as arbiter among employees, customers, and stockholders can lead to capital-expenditure policies and commitments that stray from the directional beam of capital productivity. Not that this is necessarily wrong. But, at least, when a company does let such goals as welfare or prestige govern, it ought to know the cost of such a policy. The only way to find out this cost is to determine the profitability of capital projects and see how much profit is being passed up in order to build such corporate monuments. The cost of prestige, then, is the amount of earnings foregone by departing from a pattern of investment ruthlessly directed at profit maximization.

Even where money making does dominate, the theory that a company tries to maximize its profits needs some qualification. Much more prevalent is what can be described as the doctrine of *adequate profits.* Of course, when profits performance or outlook is inadequate, the stockholder's power does come into play and capital expenditures are likely to be oriented toward profit maximization. But so long as the company is making adequate profits, the drive to have all capital expenditures selected on the basis of profit maximization is blunted.

Thus, I am well aware that making maximum profits is often not the sole or even the dominant goal in managing capital expenditures. But that does not lessen the importance of being able to measure the productivity of capital (i.e., its power to produce profits). Moreover, my viewpoint here remains that of the missionary rather than the anthropologist. As in other applications of managerial economics, the objective is to help executives improve policies, not simply to report practice (or malpractice).

YARDSTICKS OF INVESTMENT WORTH

The heart of good capital-expenditure management, then, is the measurement of the investment worth of individual proposals. But in order to measure how good a project is, we must have the right kind of yardstick. Just what should a good yardstick do?

The productivity of capital can be indicated in several ways, but the central requirement of a good yardstick is that it should measure what the proposed outlay will do to net earnings, and do this in a way that permits realistic comparison of one investment proposal with another.

EXHIBIT I. TEN COMPONENTS OF A CAPITAL-EXPENDITURE MANAGEMENT PROGRAM

A realistic way to see how these elements tie together is to trace the biography of a single project, such as a proposal to invest $10,000 in a fork-lift truck and pallets for mechanizing materials handling in a warehouse.

1. *Creative Search for Profitable Opportunities.* The first stage is conception of the underlying profit-making idea which is to be embodied in the capital facility, in this case the fork-lift truck. Turning up profitable opportunities for investing the company's capital is in part a by-product of good management. But this cannot be depended on to provide the plethora of enticing capital proposals that constitute the raw material for good management of capital expenditures. Inadvertent opportunities should be supplemented by an active program of seeking out and investigating such opportunities.

Competition is a great creator of investment opportunities, as when equipment manufacturers vie with one another to make facilities obsolete. Comparisons of costs, earnings, and facilities with those of rivals often suggest productive avenues for investment. One company has for several years been going over its entire product line with a comprehensive survey of product design and product components pointed at reducing costs by changing design, substituting materials and processes, and reconsidering past buy-or-make decisions.

2. *Long-Range Capital Plans.* The second stage in the life cycle of our fork-lift truck proposal is to see whether it conforms with long-range dreams of company development as embodied in future facilities plans.

Because today's capital expenditures make the bed that the company must lie in tomorrow, today's decisions must be based on definite assumptions as to what tomorrow will be like. For example, decisions on warehouse facilities

need to be made in the light of an over-all long-range plan for the number and general location of distribution facilities needed for the future. Based on projections of future economic conditions, some companies have prepared detailed plant and equipment targets, toward which their entire capital-expenditure program is oriented. Others have been content to draw up their future facilities plans in broad brush strokes, leaving the details to be worked out and adapted as the program is implemented.

To provide consistent bench marks for proposals originating in all parts of the organization, it is necessary to have *some kind of plan* sketched out for the future, no matter how tentative.

3. *Short-Range Capital Budget.* The next hurdle our fork-lift truck project must take is that of getting onto the one-year capital budget. Listing a project in this budget should not mean that the expenditure is authorized but only that it is approved—such *approval* indicating that the project is considered sufficiently timely and promising to warrant careful study for the coming year.

The short-run budget has several purposes. One is to force operating management to submit the bulk of its capital proposals early enough to give top management an indication of the company's aggregate demand for funds. A comparison of the capital requested with the available supply of funds will help management in weighing the desirability of outside financing or the need for cutbacks. Another purpose is to stimulate creative thinking about the capital facilities program early in the game, so that there will be a reasonable amount of time for analysis.

4. *Measurement of Project Worth.* The next stage is justification of the fork-lift project on the basis of a financial and economic analysis of its investment worth to the company. In order to permit an objective ranking of projects, this analysis needs to be summarized in a single measure of the productivity of the proposed outlay. This is the critical component of capital management and, as our central concern, will be discussed fully below.

5. *Screening and Selection.* Next, our project must pass the screening tests set up by the company to compare this fork-lift truck proposal with rival projects. Screening standards should be set in the light of the supply of cash available for capital expenditures, the cost of money to the company, and the attractiveness of alternative investment opportunities. If our project survives these rejection tests, the capital expenditure is *authorized.*

6. *Control of Authorized Outlays.* The next stage is *control* of the outlays authorized for acquisition (or construction). Controls are needed by top management at this life stage in order to assure that the facility conforms to specifications and that the outlay does not exceed the amount authorized. A system for the prevention of overages will keep estimates of investment amount "honest."

7. *Post-Mortems.* Capital-expenditure management cannot stop when our facility goes into operation. In order to preserve the integrity of the estimates of projected earnings and to provide an experience base for improving such estimates in the future, a post-completion audit of the earnings performance of our fork-lift truck is needed.

One company recently instituted a profit audit of all major projects that had been put into service in the preceding year. On a third of these projects it was found that the earnings had been overestimated by an average of 25%, including one new product investment aggregating several hundred thousands of dollars which was rendered obsolete by a competitive development two

weeks after it went into production. On another one-third of the audited projects, the available data were found to be inadequate to the task of checking on the original estimates. This points up the need for a system of record keeping which will permit competent post-completion audits.

A sound program of post-mortems can do much to make earnings estimates more conscientious and realistic. Without some comparison of projections with actual performance, estimates might be inflated to the point of making a joke of the entire capital-rationing system.

8. *Retirement and Disposal.* Management's responsibility for an investment project ceases only when the facilities have been disposed of. The usual expectation is that the asset will be retained throughout its economic life so that it will be virtually worthless at the time of disposal. In a dynamic economy, however, economic life projections are necessarily imprecise. One impact of change is that the specialized assets may come to have more value to others than to the company itself. To find out and take proper action when the future earnings' value falls below the asset's market value requires an investment analysis focused on the desirability of disposal.

9. *Forms and Procedures.* At many stages in our project's life it will have to tangle with forms and procedures. An effective system of capital-expenditure control must in any large company be implemented by specialized forms, written project analyses, and routines of approval, which are tailored to the company's needs. This paper work, though a nuisance, is essential to smooth operation.

10. *Economics of Capital Budgeting.* Good estimates of the rate of return on capital-expenditure projects require an understanding of the economic concepts that underlie sound investment decisions, as well as ability in estimating techniques. Such understanding can be achieved only through special training. To assure a good job and to underscore the importance of education for capital expenditures, the financial vice-president of one company personally conducted a training course for head-office executives and then took the show on the road to all plants.

What we seek is a measuring rod which will help decide, for example, whether a $5,000 project that will earn $2,000 a year for three years is more attractive than a $6,000 project that will earn $10,000 a year for ten years.

A good yardstick of investment worth should summarize in a single figure all the information that is relevant to the decision whether or not to make the particular investment, and none that is irrelevant. It should be applicable to all types of proposals and should permit appraisal in terms of a single set of standards. Also, it should provide an index that is relatively simple to compute; once the basic data on the proposal have been assembled, the operating people should be able to measure the project's worth easily and without any need to explain how they do it. Finally, the yardstick should permit simple adjustments to allow for ranges of uncertainty in the earnings estimates, since one of the facts to be taken into account is man's inability to see very far into the future with any great precision.

How do the three most commonly used yardsticks—(a) degree of necessity, (b) payback period, and (c) rate of return—stack up against those criteria?

DEGREE OF NECESSITY

The degree of urgency of the proposed project—that is, the extent to which it cannot be postponed to later years—is one kind of yardstick for assigning priority to investment proposals. For example, a railroad might put a power crane replacement proposal ahead of a repair shop modernization request because the old crane had broken down and something had to be done about it immediately, whereas the repair shop project could wait.

Degree of necessity has a place in the capital budgeting scheme. Some investments must be made to meet requirements imposed by a government agency. Grade-crossing eliminations for railroads, sanitary facilities in food-processing plants, and mandatory smoke-control installations are examples. Other investments clearly must be made if the company is to remain in business, e.g., replacement of a washed-out section of a railroad's main line. In these cases the alternative is such that its adoption would have a catastrophic effect on the firm's profits. Projects of this nature seldom bulk large in a company's over-all capital-expenditure program.

A serious defect of degree of urgency is that it fails to measure the capital productivity of a proposal—that is, the effect it will have on the company's earnings. A plant-modernization project may be highly postponable; but if it can produce annual savings which will yield 30% on the added capital tied up, it is to be preferred to a less postponable but less profitable project. Or, replacement of a shop destroyed by fire may seem completely unpostponable, whereas actually the company might find its over-all profits enhanced by subcontracting the operations formerly performed in the destroyed facilities.

Moreover, the degree of urgency is not a measurable quantity. Proposed projects cannot be assembled and arranged in a single priority ladder; acceptance standards cannot be set up to choose wisely among projects submitted on a necessity basis.

The most serious result of accepting or rejecting proposals primarily on the basis of how urgent they seem to be is that the capital budgeting program is likely to degenerate into a contest of personalities. The biggest share of the capital-expenditure money will go to the division heads who are the most eloquent or most persistent in presenting their requests, rather than to those who have taken the time and effort necessary to make an objective appraisal of the project's economic worth. The result is that all projects come up for review in an atmosphere of haste and

emergency, with full scope allowed for the arts of persuasion and exhortation. Not only will projects whose economic desirability is dubious be pushed through to acceptance, but also a large proportion of investments that would yield big savings and high profits may be put off almost indefinitely.

PAYBACK PERIOD

The yardstick of payback period—that is, the number of years required for the earnings on the project to pay back the original outlay with no allowance for capital wastage—is unquestionably the most widely used measure of investment worth. Payback is superior to postponability since it takes into consideration the projected gross earnings, and it does have certain uses in capital-expenditure management:

> Payback can serve as a coarse screen to pick out high-profit projects that are so clearly desirable as to require no refined rate-of-return estimates and to reject quickly those projects which show such poor promise that they do not merit thorough economic analysis. In addition, it may be adequate as a measure of investment worth for companies with a high outside cost of capital and severely limited internal cash-generating ability in comparison with the volume of highly profitable internal investment opportunities. If a shortage of funds forces the company to accept only proposals which promise a payback period after taxes of two years or less, the use of a more refined measure might not affect the list of accepted projects.
>
> It also can be useful for appraising risky investments where the rate of capital wastage is particularly hard to predict. Since payback weights near-year earnings heavily and distant earnings not at all, it contains a sort of built-in hedge against the possibility of a short economic life.

For most corporations, however, payback is an inadequate measure of investment worth. It is a cash concept, designed to answer the single question of how soon the cash outlay can be returned to the company's treasury. As such it fails in three important respects to provide a satisfactory yardstick for appraising all the profit-producing investments of a firm:

1. Payback tends to overweight the importance of liquidity as a goal of the capital-expenditure program. No firm can ignore needed liquidity. But most can achieve it by means that are more direct and less costly than sacrificing profits by allowing payback to govern the selection of capital projects.
2. It ignores capital wastage. By confining analysis to the project's gross earnings (before depreciation) it takes no cognizance of its probable economic life.
3. It fails to consider the earnings of a project after the initial outlay has been paid back. By concentrating on liquidity, it ignores the vital matter of what the life pattern of the earnings will be. Up to the end of the payback period the company has just got its bait back. How much longer the earnings will last is what determines the profitability of the investment. A three-year payback project may yield a 30% return on average investment if it has a

long life, but only 12% if its life is four years, and no return at all if just three years.

In short, because payback does not measure or reflect all the dimensions of profitability which are relevant to capital-expenditure decisions, it is neither inclusive enough nor sensitive enough to be used as the company's over-all measure of investment worth.

RATE OF RETURN

Measurement of the economic worth of an investment proposal by means of rate of return relates the project's anticipated earnings to the amount of funds which will be tied up during the investment life of the facility. Rate of return embodies the concept of *net* earnings after allowing for capital wastage. Neither degree of necessity nor payback period uses this concept, since payback is measured in terms of gross earnings, and urgency does not consider earnings at all.

Rate of return has its shortcomings. A sound rate-of-return system is more complex than most of the methods of rationing a corporation's capital that are in current use. It costs more to install and put into operation. Also it may run into obstacles because it is unfamiliar and possibly because it will block privileged channels from access to capital funds.

But such limitations should not be decisive. Good management of capital expenditures is too vital to be blocked by ignorance, caution, or smugness. Overcoming the old organization's natural resistance to learning new tricks and training it in a new pattern of thought about capital expenditures is a one-shot affair. Once the system is installed, very little effort and cost are needed to keep it going.

Superiorities of This Yardstick. The positive superiorities of a rate-of-return measure of investment worth are imposing. It takes account of the full lifetime of a capital-expenditure proposal. Two projects, each of which shows a three-year payback, may differ greatly in the length of time for which they will produce earnings for the company. Take this experience which one company had:

> Certain refinery equipment that showed a three-year payback actually became obsolete and was replaced in less than three years. This project's rate of return, therefore, was less than zero, despite what appeared to be a very satisfactory payback. In contrast, a pipeline that had the same three-year payback kept on earning (and promises to continue for twenty years more). Clearly its rate of return was much higher.

Capital wastage—that is, the gradual loss of the economic value of the facility over a period of time—is of vital importance in the appraisal of an investment proposal. Capital productivity should be measured by earnings over the whole life of the investment, even though estimates of the distant future may be subject to wide margins of error.

Because rate of return considers the full life of an investment proposal, correct comparisons of the degree of value of projects can be made. Proposals can therefore be arranged in a ladder of priority even where they seem to be of the same degree of urgency or to have the same payback period. Moreover, the fact that the projects themselves may differ widely in their characteristics does not impede the comparison. New-product investments can thus be compared with cost-reducing projects; or a proposal this year can be compared with one which will not be ready until next year.

Better standards of rejection are made possible by rate of return. A company's combined cost of capital—say, 15%—can be used to determine the proper rate of cutoff on the capital-demand ladder just discussed; i.e., the minimum acceptable profitability of a proposal. This not only provides an objective, defensible basis for acceptance or rejection; it also aids top management in delegating authority by providing sound bench marks for personnel down the line to use in killing off the worst propositions before they have gone far up the chain of command.

Finally, rate-of-return rationing is likely to produce more earnings for stockholders, since it directs the flow of funds to their most profitable use by measuring the productivity of capital correctly and comparing it with a relevant standard of acceptable profitability.

MAKING THE ESTIMATES

We have seen that for most companies rate of return is the best yardstick of economic worth. Two problems arise in the practical application of this yardstick. The first concerns the concept for making the empirical projections that are needed to get the three basic determinants of project worth: (a) earnings, (b) economic life, and (c) amount of capital tied up. The second problem (discussed later) is how to combine these determinants in an index of profitability.

TEN FALLACIES

The part of this measurement problem which is most often muffed is the job of getting a clear idea of just what needs to be estimated. Why should there be any problem in clarifying the concepts for rate-of-return measurement? The nature of the difficulties and their importance for good measurement can be seen by looking at ten common fallacies:

1. "*No Alternatives*." Perhaps the most common mistake in analyzing a capital proposal is the failure to consider any alternatives. There are always alternatives to an investment proposal, and a systematic analysis of the alternatives is the bench mark for estimating both the investment and the earnings of

a capital project. What will happen if the requested investment is not made measures what the company will get out of it if the investment is made. If, as usual, there are several alternatives differing in the amount of investment required, earnings estimates should logically be built upon the smallest investment alternative which is acceptably profitable. Alternatives which require greater investment are preferable to this one only if the *added* investment over this amount produces enough *added* earnings to yield a satisfactory rate of return.

2. "'*Must*' *Investment*." Closely related is the "must" investment fallacy. The common conviction that certain equipment replacements are indispensable for continuing operations implies that top management has no alternatives. True, the alternative is sometimes so catastrophic that it is academic. But even in such a case the reason for making the investment should not be that it is urgent or indispensable, but that its profitability is terrific measured against the catastrophic alternative. Thus the rate of return from replacing a burnt-out pump in an oil pipeline may be astronomical; the investment is small and its earnings are the profits from the whole line, since the only alternative is a complete shutdown.

High-profit investments of this special nature are rarer than realized. Skeptical study of supposed "must" investments will reveal alternatives to many of them and will show that some of them are neither necessary nor even acceptably profitable.

3. "*High Strategy*." Another fallacy is the notion that some projects are so pivotal for the long-run welfare of the enterprise that they possess high strategic value which overrides mere economic considerations and lifts their evaluation into a mystic realm beyond the ken of economic and financial analysis. For example, the dogma that an integrated oil company should own 75% of its crude oil sometimes precludes economic analysis of integration investments.

It is true that some capital expenditures do have benefits which are hard to measure because they are diffused over a wide area of company activity or because they stretch over a protracted time period. And there are some investments which must be made on almost pure faith (e.g., a new research center). Nevertheless, the idea that there is such a thing as strategic value not ultimately rooted in economic worth is demonstrably wrong. If a contemplated investment produces results that do not have any economic value, then directors and stockholders should question its wisdom.

4. "*Routine Replacement*." This fallacy maintains that scheduled periodic replacement of capital facilities is a practical and inexpensive substitute for an investment analysis of the economic desirability of individual replacements. For example, many fleet owners replace motor trucks on a routine basis (i.e., after a certain number of years or a certain number of miles), without determining whether the added net earnings from replacing this or that old truck with a new one will produce an adequate return on the specific added investment. Routine replacement has the virtues of simplicity, orderliness, and predictability. But vintage retirement will not produce as profitable a pattern of investment as will a capital-earnings plan.

5. "*Prediction is Impossible*." Scoffers maintain that since the future cannot be predicted with accuracy, it is futile to try to guess the useful life of a proposed facility or to project its earnings beyond the first year. The consequence of this fallacy is an unwillingness to define concepts in a way that will force explicit projection. People try to duck out by proclaiming that "with a

four-year payback, it doesn't matter" or by embracing "unfair" Bureau of Internal Revenue depreciation rates.

The basic mistake is refusing to recognize that forecasting, though difficult and subject to error, is nevertheless necessary in appraising the worth of capital projects. Prediction, whether or not it is done consciously, lies at the heart of any executive judgment about a proposed investment. Usually it is better to *know* what is being done.

6. *"Fair Share of Overhead."* A common error in project analysis is to use allocations of current overhead instead of estimating the added costs that will be caused by the project. This cost-proration fallacy confuses problems of equity with problems of economic consequences. This is illustrated by a question frequently raised: Should a new product line, acquisition of which is being contemplated, carry its full share of the overhead now borne by mature products, or should it get a free ride? Neither of these suggested solutions is correct, at least for estimating project earnings. Old overheads do not matter—only new overheads. What is needed is not a reallocation of past overheads but a forecast of how future overheads will increase by acceptance as opposed to rejection of the project. This cost increment is wholly unaffected by the conventions of apportionment of common costs.

7. *"Free Ride."* A related fallacy that frequently misguides analysis of capital proposals errs in the opposite direction. It holds that new products or added volume are "plus business" in the sense of incurring negligible additional costs. This "free ride" fallacy leads to the conclusion that earnings from expansion investments are almost equivalent to their revenue. There is something to this notion; long-run incremental costs are often smaller than fully allocated average costs. But they are larger than short-run marginal costs and never negligible.

While short-run marginal costs are relevant for operating decisions, long-run added costs must be used for investment decisions. Herein lies the peril of the "free ride" fallacy. What, for instance, are the earnings from an added gasoline service station when pipeline and bulk plant capacities will just take that added volume? If only the marginal cost of using this bulk-movement capacity is included, rate of return is high. But continued normal growth will soon force expansion of the bulk-movement capacity; the new service station brings this time that much closer. If the full cost of this expansion is included in estimating lifetime earnings, the return of course shows up as much lower.

8. *"Carrying Charge."* The practice of charging the earnings of all projects with an interest cost might be called the "carrying charge" fallacy. Usually this charge is computed by applying the company's short-term borrowing rate to the capitalized portion of the original investment. This approach has the virtue of recognizing that money is not costless, even though no entry is made in the accounts. It has, however, two defects: (a) it uses the wrong cost of money, since high-cost equity capital is left out, and (b) it introduces cost of money into the capital-management program in the wrong way. Instead of substracting carrying costs from individual projects, it is better to use cost of capital as a cutoff rate to select acceptably profitable projects.

9. *"Book Value."* Determination of the investment amount looks so easy that it is often done wrong. Bookkeeping is the root of error here. Accounting conventions that are indispensable for financial reporting give the wrong steer for estimating a project's investment base. The test of what should be included in the investment amount is not how it is handled on the books, which bears only on the tax effects of the proposal, an important but quite separate issue.

The test is whether or not the outlay is necessary to produce the stream of earnings contemplated in the proposal.

The "book value" concept would exclude outlays that are expensed (rather than capitalized) from the amount of investment serving as the base for the rate-of-return estimate. Take a proposal to convert an unused portion of a building into a sausage factory requiring $100,000 of capitalizable machinery plus $150,000 of expensed repairs. The pretax investment amount is the whole $250,000; after deflating the expensed portion for 50% income tax rates ($150,000 minus $75,000), the after-tax investment amount is seen to be $175,000. But the book value is only $100,000.

Book value also gives bad investment guidance in propping up, transferring, or abandoning existing assets. The book value of an existing asset is based on recorded historical cost less accumulated depreciation. For investment decisions, its value should be determined by what the company can get for the asset or what the company can do with it in its next best internal use, rather than by the figures that happen to be on the books.

10. *"Taxes Don't Matter."* There is a surprisingly widespread conviction that adjustment for corporate income taxes is academic. This "taxes don't matter" fallacy assumes that the underlying worth of a project is obscured (rather than revealed) by allowing for tax effects, and that the ranking of capital products will be the same whether or not they are deflated for taxes. This beguiling notion is wrong in two respects: (a) In order to apply tenable acceptance standards such as the company's outside cost of capital, it is necessary to measure rate of return after taxes, rather than before taxes. (b) The impact of taxes differs depending on the time shape of the project; and the after-tax ranking of proposals will differ significantly from their before-tax ranking if taxes are correctly taken into account in computing rate of return. For example, the tax effects of accelerated amortization can convert a border-line project into a highly profitable investment opportunity.

POSITIVE CONCEPTS

Having looked at these ten fallacies, we are in a better position to formulate positive concepts of what needs to be estimated in measuring project earnings and project investment.

A correct estimate of earnings must be based on the simple principle that the earnings from a proposal are measured by the total *added* earnings or savings from making the investment as opposed to not making it. The proper bench mark for computing earnings on a project is the best *alternative* way of doing the job; comparison therewith will indicate the source and amount of the added earnings. Project costs should be unaffected by allocations of existing overheads but should cover all the changes in total overhead and other costs that are forecasted to result from the investment, but nothing else—nothing that will be the same regardless of whether the proposal is accepted or rejected.

The value of a proposed investment depends on its future earnings. Hence, the earnings estimate should be based on the best available projections of future volume, wage rates, and price levels. Earnings should be estimated over the economic life of the proposed facilities. Because

project earnings vary in time shape, and because this will affect the rate of return, the earnings estimates should reflect the variations in the time trend of earnings.

In estimating economic life of an investment, consideration must be given to (a) physical deterioration, (b) obsolescence, and (c) the possibility that the source of earnings will dry up before either of the first two factors becomes operative.

Interest on investment should not be deducted from project earnings. Charging interest increases the complexity of the rate-of-return computation without adding to the information it provides. Earnings should be stated after corporate income taxes, for only in such form are they relevant for capital attraction and for dividend payment.

The appropriate investment base for calculating rate of return is the added outlay which is occasioned by the adoption of the project as opposed to rejecting it and adopting an alternative which requires less investment. The entire amount of the original added outlay should be included in the investment amount, regardless of how it is treated in the books. Any tax benefit which results from expensing certain items rather than capitalizing them should be reflected. Those repairs which would be made whether or not the proposal is adopted should be excluded from the investment amount, because they are not caused by it.

If the proposal involves a transfer of facilities from another part of the company, the opportunity cost of these facilities (the amount foregone by using them this way rather than another) should be added to the amount of investment. If the opportunity foregone is merely to sell the facilities for scrap, then this will indicate the value to set on the transferred assets.

The amount of the investment should also include the amount of any additional necessary investment in working capital or other auxiliary facilities. Research and promotional expenses to get new products rolling or to develop new methods or to expand business are no less investments than plant and equipment.

CALCULATING RATE OF RETURN

Once the basic estimates of project earnings and investment have been made, there are two major ways of combining them into a rate-of-return measurement. One way—which can be called the "accounting method" because it is closely related to many of the concepts used in conventional accounting procedure—computes rate of return as the ratio of (a) the project's earnings averaged over the life of the proposition to (b) the average lifetime investment. The other—which can be called "discounted cash flow"—computes rate of return as the maximum interest rate which

could be paid on the capital tied up over the life of the investment without dipping into earnings produced elsewhere in the company.

ACCOUNTING METHOD

A characteristic of the accounting method is that it has many variants, each of which produces a different rate-of-return figure for any one investment proposal. One set of variants comes from diverse concepts of the investment amount (e.g., the original outlay, $100,000, versus the average amount tied up in the facility over its life, $50,000). Another source of variants is the diverse concepts of the project earnings. Earnings can be either gross or net of depreciation, either before or after taxes. They can be the average for several years or for the first year only. This variety of alternatives produces a tremendous range of rate-of-return results. But they all fall into the category of accounting method, provided the final result is a ratio of earnings to investment.

This shortcoming can be minimized only by arbitrarily standardizing on one variant of the method and making all computations according to this standard.

A more serious drawback to the use of the accounting method is that it is insensitive to variations in the time pattern of investment outlays and earnings. By taking an annual average of earnings over the life of a project this method ignores the earning trends, which may be quite important.

The economic worth of an investment will be affected by the time shape of its lifetime earnings, because near money has greater economic value than distant money. For example, an oil well has a strikingly different time shape than a service station. A well which comes in as a gusher trails off to a pumper. In contrast, a service station in a new area has a rising curve of earnings and is likely to show post-operative losses in the first year or so. Failure to reflect these time-shape disparities in the index of investment worth leads to unprofitable capital-expenditure decisions.

The effect of time shape on economic worth is especially great when the company's cost of capital is high or when the foregone earnings on projects that are passed up are high. Only a company whose investment projects are roughly similar in time shape and in economic life can ignore this feature. For such a firm the added accuracy of the discounted-cash-flow method probably does not justify the transitional pain and effort required to install the system. But any company which has projects that vary significantly in either time shape or longevity has an important stake in using the most sensitive rate-of-return method available.

DISCOUNTED CASH FLOW

The mechanics of the cash-flow method consist essentially of finding the interest rate that discounts future earnings of a project down to a

present value equal to the project cost. This interest rate is the rate of return on that investment. EXHIBIT II illustrates the way in which rate of return can be determined under the cash-flow method for a cost-reducing machine which costs $2,200 and has an anticipated life of five years with no salvage value at the end of that time. In this case, an interest rate of 20% is found to make the present value of the future earnings stream equal to the present cost of the machine, so this is the rate of return.

EXHIBIT II. CASH-FLOW METHOD OF COMPUTING RATE OF RETURN ILLUSTRATED

(Machine costing $2,200 with anticipated life of five years and no salvage value at the end of that time)

Year	*Gross earnings before depreciation*	*Present value of earnings discounted at* 18%	20%	22%
1	$ 200	$ 184	$ 182	$ 180
2	600	458	446	432
3	800	510	486	462
4	1,200	640	596	556
5	1,200	534	488	448
Total	$4,000	$2,326	$2,198	$2,078

Conceptually, this method is based on the principle that in making an investment outlay we are actually buying a series of future annual incomes—ranging in the example in the exhibit from $200 the first year to $1,200 by the fourth and fifth years. We have an investment in each of those incomes, an investment which compounds in value through time until its own year arrives and it materializes in cash earnings. Thus, for example, the $596 present value of the fourth year's earnings at 20% is the amount that would have to be invested at 20% now to yield $1,200 gross earnings during the fourth year ($596 compounded at 20% for 3½ years—since the $1,200 would begin to come in at the beginning of the fourth year).

The basic simplicity of this method is brought out by this illustration. Earnings are stated as gross cash receipts (not figuring depreciation). Therefore, it is not necessary to allocate the cost of the machine over its life before computing return. Depreciation is allowed for automatically because the interest rate that discounts the sum of present values to zero is the rate of return on the investment after annual provisions for repaying the principal amount. We are not, as in the accounting method, watching the write-off of original cost; we are watching instead the growth of our investment outlay as we compound it through time.

The method is simplified by the fact that there is no need to make a decision as to which earnings base to use (e.g., original outlay, average investment, and so on), nor is there any need to enter interest as a direct cost of the project. Once the data are gathered and set up, there is only one rate-of-return answer possible, and it can be arrived at by straightforward working of charts and interest tables.

Net Superiority of Discounted Cash Flow. The accounting method does have the advantage of familiarity and transparency. Although education would be necessary to get everyone to standardize on one method of averaging earnings and investment, the idea of computing a simple ratio by dividing one number by another is familiar to anyone who went beyond the second grade.

The discounted-cash-flow method admittedly is less familiar. While a method essentially similar to this has been widely used throughout the financial community for computing bond yields, insurance premiums, and rates on leased facilities where accuracy is important and even small errors may cause serious loss, it is new in its application to the measurement of productivity of individual capital-expenditure projects in industry. Hence the job of explaining it to the bookkeeper and the clerk will require time and effort. But its appearance of complexity is deceptive. Once the basic method is understood, it is actually simpler and quicker to use than the accounting method.

Another deterrent to its use is the fact that it does not correspond to accounting concepts about the recording of costs and revenues, so that special analysis is necessary to compute a post-mortem on an investment made in the past. But this seems minor in comparison with its imposing superiorities:

1. The discounted-cash-flow method is economically realistic in confining the analysis to cash flows and forgetting about customary book allocations. The books, although very valuable for other purposes, are irrelevant for the task of measuring investment worth.
2. The use of this method forces guided thinking about the whole life of the project and concentration on the lifetime earnings.
3. It weights the time pattern of the investment outlay and the cash earnings from that outlay in such a way as to reflect real and important differences in the value of near and distant cash flows.
4. It reflects accurately and without ambiguity the timing of tax savings, either from expensing part of the investment outlay or from writing off capitalized costs over the life of the investment—something quite difficult to do by the accounting method.
5. It permits simple allowances for risks and uncertainties and can be adapted readily to increasing the risk allowance over time.
6. It is strictly comparable to cost-of-capital ratios so that decisions can be made quickly and safely on the basis of the relationship between indicated rate of return and the value of money to the company.

50. THE PROFITGRAPH–TECHNIQUE AND APPLICATIONS

Leland G. Spencer*

Extensions of the breakeven analysis and variable budgets are called by various names. The present author uses the term "profitgraph" in a broader sense than implied by its origins.

The purpose of this presentation is to outline some of the techniques involved in the construction of profitgraphs and to illustrate a few of their practical applications in the management of an industrial enterprise. It is not intended to picture the profitgraph as a complete solution of management's many problems nor to ignore the fact that it has definite limitations. Rather, emphasis will be placed on the fact that the profitgraph is designed primarily as a simplified management tool which indicates the probable pattern of gross margin, net income, return on investment, etc., under a given set of conditions. When used as such, it can provide assistance to management in computing and comparing product profit contribution and potential, measuring operating unit profit performance, and formulating policies.

In order to construct a profitgraph, it is essential that we have a sound knowledge of volume, price, cost, investment, taxes, etc. Most important of these is price and cost and, in turn, a knowledge of how cost behaves with a changing volume. Also of importance, is the effect of changing volumes on investment. It is obvious, then, that the construction of accurate profitgraphs is dependent, to a large degree, upon the availability of sound breakeven analysis data. In turn, these are dependent upon the construction of sound fixed and variable budgets.

FUNDAMENTALS: BREAKEVEN ANALYSIS

The first step in a breakeven analysis is that of determining the breakdown between costs which are fixed and those which are variable. The means of doing this has already been indicated but it should be added that, to obtain an accurate picture of profit possibilities, it is essential that the breakeven chart be prepared on the basis of expected price levels, expected fixed costs and expected variable costs. Likewise, it is essential that current performance be checked in order to determine what changes are taking place in any or all of the factors and the effect of such changes

* From *National Association of Cost Accountants Bulletin,* XXXVIII, 4 (1956), 493-507. Reprinted by permission of the National Association of Accountants.

on our expected profit. Definitions given in connection with variable budgeting are relevant here also, with the addition of several others. Contribution margin is the excess of sales over variable product cost. It represents the balance available for absorption of fixed costs and for profits and taxes. The breakeven point is the volume at which sales and total cost are equal, total cost being the sum of variable and fixed costs.

Breakeven analysis is based on the principle that there are three primary factors which determine the extent of profits for a given period:

1. Volume or the amount of activity of an enterprise during the period.
2. Sales mix or the volume relationship of the various products and the channels through which these products are sold, which combine to produce the sales income for the period.
3. Operating efficiency or the performance of management in the control of costs and investment in the operation of the business.

A realistic determination, analysis and interpretation of profits requires that these three factors be clearly distinguished if the facts as to why profits vary are to be found. A breakeven type of analysis can be used to show the effects on the volume-profit relationship of any program altering fixed costs. As to sales mix, the selling price-cost characteristics for different products vary, with the result that some products are more profitable than others. A breakeven type of analysis develops two separate measures of the relative profitability of products. The choice of which methods to use is dependent on the length of the period involved. For purposes of long-range planning, where practically all fixed costs are flexible, the determination of a breakeven point for each product line provides a means of comparing the profit potentials of the various product lines. This type of information will assist management in its planning of product lines, channels of distribution, facilities, organizations, etc. From a short-range viewpoint, however, where fixed costs are relatively stable, contribution margin, expressed as a percentage of sales, provides a more effective measure of the relative profitability of products and the effect of sales mix on profits for the period.

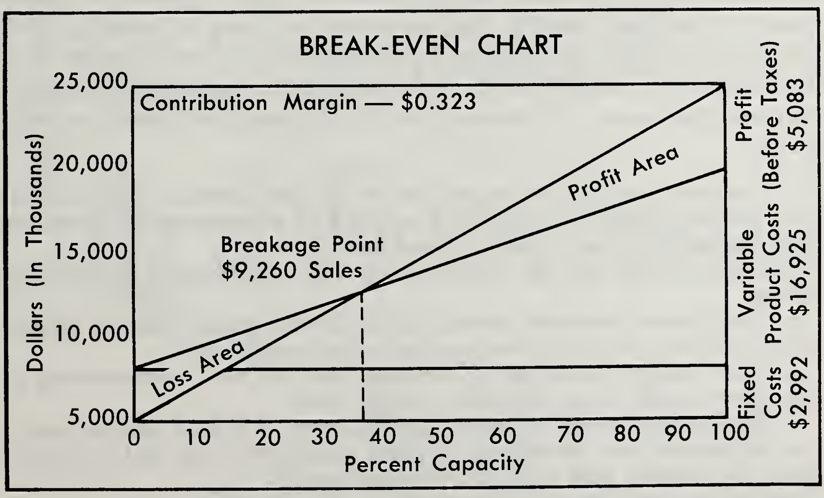
With respect to operating efficiency, breakeven charts assist management in improving operating efficiency in two ways. First, it is helpful as a planning device. Breakeven analyses can be used in comparing alternative courses of action and determining the effects on profits of proposed projects. There are several ready examples. In advertising campaigns, the additional sales volume that must be produced as a result of the campaign to cover its cost can be determined. For facilities planning, the cost of additional facilities as compared with the resulting lower cost production or increased capacity may be obtained. In cost reduction projects, breakeven analysis will show cost of new methods versus the savings resulting from their application. Breakeven analysis serves also as a budgetary control technique.

Application of breakeven principles to the business situation used in this paper can be illustrated by the simplified breakeven chart shown in EXHIBIT 2. It plots the following data:

			($ in Thousands)		
Sales	*Variable product cost 67.7%*	*Contribution margin 32.3%*	*Fixed cost*	*Profit (Loss)*	*Profit before taxes % to sales*
$ 2,500	$ 1,693	$ 807	$2,992	$(2,185)	(87.4) %
5,000	3,388	1,612	2,992	(1,380)	(27.5)
7,500	5,078	2,422	2,992	(570)	(7.6)
9,260	6,268	2,992	2,992	Breakeven	–0–
10,000	6,768	3,232	2,992	240	2.4
15,000	10,148	4,852	2,992	1,860	12.3
20,000	13,548	6,452	2,992	3,460	17.3
25,000	16,938	8,062	2,992	5,070	20.3

The figures and the chart indicate that fixed costs are $2,992,000 in the operating unit used for example purposes and that variable product costs are equal to 67.7 per cent of sales. The contribution margin then, is 32.3% (100.0 — 67.7) and the breakeven point $9,260,000 ($2,992,000 ÷ 323) or 37 per cent of capacity.

EXHIBIT 2[1]



[1] Exhibit 1 and fundamentals of breakeven and variable budgeting have been omitted here.

For all sales volumes of less than $9,260,000 there is a loss, and for volumes in excess of $9,260,000 there is a profit.

THE PROFITGRAPH ITSELF

All of the available source material appears to indicate that the term, "profitgraph," has been used as another term for the breakeven chart. Although breakeven analysis represents the groundwork on which the profitgraph is built, the breakeven chart simply establishes the profit-volume characteristics of a business, based on the segregation of fixed and variable costs from the total cost picture. It serves as an indicator of profit or loss at specific sales volumes. The term "profitgraph" should be used in a much broader sense.

The underlying principle back of the profitgraph is that the application of fixed and variable costs segregation through breakeven and investment analysis makes available additional management guidance data in the form of profit measurements, i.e., gross margin, net income, return on investment, etc. With sound basic data, these performance measurements can be quickly calculated for changing conditions and can be reflected in a form which will carry weight as the expression of a technique used in a professional manner, thus serving as aids to management in making forward decisions. Not only should the profitgraph be employed to indicate the sales breakeven point and the profit at any level of capacity. It should also reflect patterns of gross margin, net income, return on investment, etc., ratios under a given set of conditions. Further, it should be flexible enough to facilitate, quickly, the development of changing patterns which result from changes in the given set of conditions or any element in it. To assure a clear understanding of the technique of profitgraph construction and application, it is essential that the following definitions be established:

1. Breakeven analysis—the segregation of all costs between those that are fixed and those that are variable for purposes of determining the breakeven point and profit or loss at specific volume levels.
2. Cost—the total cost of manufacturing and distributing a specific sales volume.
3. Capacity—the maximum output available from a specific plant or product section of a plant, normally calculated on a 5-day 3-shift basis.
4. Gross margin—the difference between sales and total manufacturing or plant cost, i.e., before factoring cost of distribution.
5. Net income—income remaining after payment of federal income taxes.
6. Investment—total investment in plant, inventories, cash, and receivables less reserves against these assets, and accounts payable.
7. Return on investment—ratio of net income to investment.
8. Per cent of market—ratio of current sales volume to total available market.

As pointed out above, the construction of the profitgraph requires breakeven and investment analyses. EXHIBIT 3 depicts the same business

EXHIBIT 3

BREAKEVEN COST ANALYSIS TOTAL PLANT

	Volume Level (Percent of 5 Day–3 Shift Capacity)								Breakeven Analysis			
	48%		60%		80%		100%		Fixed		Variable per $1,000,000 of Sales	
	Amount	Emps.	Amount	Emps.	Amount	Emps.	Amount	Emps.	Amount	Emps.	Amount	Emps.
Sales billed	$10,000,000	—	$15,000,000	—	$20,000,000	—	$25,000,000	—	—	—	$1,000,000	—
Cost of Sales												
Direct material	4,000,000	—	6,080,000	—	3,000,000	—	10,000,000	—	—	—	400,000	—
Direct labor	1,000,000	280	1,500,000	420	2,000,000	560	2,500,000	700	—	—	100,000	28
Ind. mfg. expense												
Supervision	330,000	40	270,000	47	300,000	52	340,000	59	160,000	27	7,200	1.3
Quality control	90,000	19	120,000	26	160,000	35	190,000	42	23,000	4	6,700	1.5
Clerical	110,000	30	140,000	40	160,000	47	180,000	53	75,000	18	4,200	1.4
Handling and expediting	230,000	60	300,000	63	380,000	108	460,000	133	77,000	12	15,000	4.8
Personnel & employee service	50,000	6	70,000	7	90,000	8	100,000	9	17,000	4	3,309	0.2
Payroll premiums	100,000	10	240,000	15	300,000	20	360,000	25	60,000	—	12,000	1.0
Tools and supplies	300,000	—	420,000	—	940,000	—	660,000	—	60,000	—	24,000	—
Utilities	300,000	6	400,000	6	500,000	6	600,000	6	100,000	6	20,000	—
Manufacturing methods	140,000	15	150,000	16	100,000	19	210,000	22	90,000	11	4,300	0.4
Maintenance	280,000	44	350,000	54	430,000	64	510,000	74	127,000	24	15,300	2.0
Other operating expense	80,000	—	120,000	—	160,000	—	200,000	—	—	—	8,000	—
Employee benefits	250,000	—	340,000	—	430,000	—	520,000	—	70,000	—	18,800	—
Total—controllable	2,240,000	230	2,920,000	294	3,630,000	359	4,330,000	423	859,000	106	138,800	12.6
Fixed charges	600,000	—	600,000	—	600,000	—	600,000	—	600,000	—	—	—
Assessments	100,000	—	100,000	—	100,000	—	100,000	—	100,000	—	—	—
Total—non-controllable	700,000	—	700,000	—	700,000	—	700,000	—	700,000	—	—	—
Total—I. M. E.	2,940,000	230	3,620,000	294	4,330,000	359	5,030,000	423	1,359,000	106	138,800	12.6
Engineering expense (P. E. C. E.)	500,000	25	540,000	27	570,000	29	600,000	31	433,000	21	6,630	0.4
Transportation and containers	120,000	—	100,000	—	240,000	—	300,000	—	—	—	12,000	—
General expense	1,200,000	40	1,300,000	44	1,400,000	48	1,500,000	52	1,000,000	32	20,000	9.3
Total—cost of sales	$ 9,760,000	575	$13,140,000	735	$16,540,000	996	$19,930,000	1,206	$2,992,000	159	$ 677,430	41.8
Income from sales												
Amount	$ 240,000		$ 1,360,000		$ 3,460,000							
Percent	2.4%		12.4%		17.3%							

situation for which data was introduced for the charts already given in this paper. This provides the breakeven analysis. An analysis of investment is, therefore, the next "order of business." This is supplied by EXHIBIT 4, at several sales volumes. In connection with it, the following particulars of the business situations dealt with may be helpful. Component manufacture is similar to the plastics industry. There are four product lines with substantially different types of manufacturing processes. Credit terms are 30-days, with experience of 30-day average receivables balance. Purchase payment terms take advantage of cash discount where available. Average unpaid invoices equal 20-day purchases. Current age of plant is 3 years. Weighted average depreciation period is 10 years. The manufacturing cycle is very short, averaging about one week. Inventories are limited almost entirely to raw material and work in process, except for one product line which carries a one-month inventory of finished goods.

EXHIBIT 4

INVESTMENT
($ in thousands)

	Sales Volume				
Item	$5,000	$10,000	$15,000	$20,000	$25,000
Manufacturing Plant	$6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Inventories (Fixed $130)	390	650	910	1,170	1,430
Receivables	417	833	1,250	1,667	2,083
Cash	531	813	1,095	1,378	1,661
Total Gross	$7,338	$ 8,296	$ 255	$10,215	$11,174
Reserves					
Plant	$1,800	$ 1,800	$ 1,800	$ 1,800	$ 1,800
Inventories	50	60	70	80	90
Other	21	37	50	58	62
Total	1,871	1,897	1,920	1,938	1,952
Accounts Payable	270	365	460	555	650
Total—Reductions of investment	$2,141	$ 2,262	$ 2,380	$ 2,493	$ 2,602
Net Investment	$5,197	$ 6,034	$ 6,875	$ 7,722	$ 8,572

Inventory turnover is 17 for raw material, 40 for work-in-process, and 12 for finished goods, with a composite turnover of 18 (at 20,000,000 sales volume level). Cash is kept at one month's requirements.

All of the data required for completion of the profitgraph is now in place. To facilitate the construction of this management guide and to

present a clearer picture of the tie-in of the basic data with the profitgraph itself, this data may be summarized as follows:

	Sales Volume ($ in thousands)				
	$ 5,000	$10,000	$15,000	$20,000	$25,000
Sales Income	5,000	10,000	15,000	20,000	25,000
Total Cost	6,380	9,760	13,140	16,540	19,930
Income from Sales	(1,380)	240	1,860	3,460	5,070
Federal Income Taxes (52%)	—	125	969	1,799	2,636
Net Income	$(1,380)	$ 115	$ 891	$ 1,661	$ 2,434
Investment	$5,197	$ 6,034	$ 6,875	$ 7,722	$ 8,572
Return on Investment	(26.6)%	1.9%	13.0%	21.5%	28.4%
Gross Margin Amount	$ (280)	$ 1,440	$ 3,160	$ 4,860	$ 6,570
Percent to Sales	(5.6)%	14.4%	21.1%	24.3%	26.3%

The profitgraph constructed from this data is shown in EXHIBIT 5.

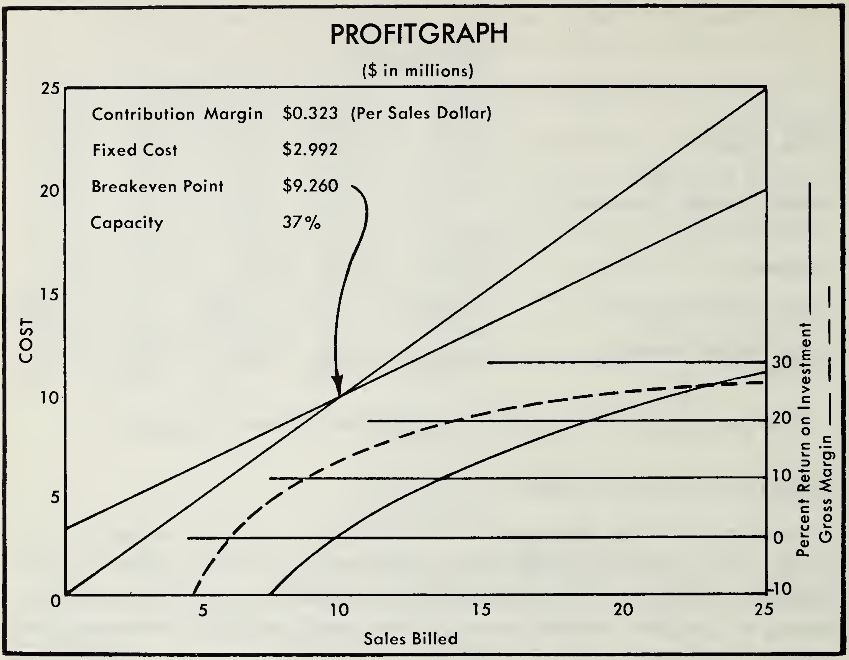
PROFITGRAPH APPLICATIONS

Among the basic objectives of any business are the realization of a profit (the degree of profit being sufficient to attract capital into the business and to pay a fair return on that investment), production and marketing of products which have the best profit potential, maintaining an organization which performs efficiently, and keeping a proper balance between men and machines, i.e., the proper degree of mechanization. Obviously, the most important tools which can be made available to management are financial guides, those that will predict or forecast the effect of planned management action and measure the effect of management action and the performance of management at various levels. It is in this wide area that profitgraphs are of invaluable assistance. The remaining pages of this article will present practical applications of profitgraphs in each of several specific areas of assistance:

1. Determination of product line profit contribution.
2. Determination of plant (and broader area) profit contribution.
3. Decision making on plant expansion or mechanization.
4. Decision making on pricing policy.
5. Measurement of performance.

The first of these areas is determination of profit contribution by product line. Where profitgraphs of the type described by this paper have been used, they have been generally limited to plant operations. There has been a feeling that it is next to impossible to accurately segregate specific costs and specific items of investment by product line within a plant in a large percentage of the cases. Satisfaction with this attitude

EXHIBIT 5



results in the continued sales of products which are loss items in plain "dollars and cents" or which represent true loss items when the low profit margin and the unbalanced talent requirement are factored, i.e., investment in high salaried talent should be carefully weighed when the profit picture of a specific line approaches the "minimum" goal. On a long range basis, profits can be improved by dropping such lines and putting the best talent to work in other more promising areas.

Fortunately, in the business situation reflected here, progress has been made in efforts to measure profits by product line within a plant. The progress that has been made in product-line profit analysis has come about through better definitions, finer segregation, and control of service expense on a fixed and variable basis. This improvement resulted from either a desire for more accurate costs by product line or the demand for and the effecting of better control of the service sections.

Each product line is a business on its own and the supervisor has the direct responsibility for its profitability. He is informed, in advance, of the amounts which will be assessed against his product for operation of each service section. These figures are in terms of "dollars per week—fixed" and "dollars per activity unit—variable." In turn, knowing his

EXHIBIT 6

BREAKEVEN COST ANALYSIS BY PRODUCT LINE
($ in thousands)

	Total		Product Line* A		Product Line* B	
	Amount	% Sales	Amount	% Sales	Amount	% Sales
Sales Billed	$25000	100.0%	$10,000	100.0%	$3,000	100.0%
Cost of Sales						
Variable						
Direct Material	$10,000	40.0%	$ 3,100	31.0%	$ 900	30.0%
Direct Labor	2,500	10.0	1,200	12.0	150	5.0
I.M.E.	3,471	13.9	1,341	13.4	210	7.0
P.E.C.E.	167	0.6	67	0.7	15	0.5
General Expense	500	2.0	130	1.3	50	1.7
Transportation	300	1.2	120	1.2	30	1.0
Total	$16,938	67.7%	$ 5,958	59.6%	$1,355	45.2%
Fixed						
I.M.E.	$1,559		$ 749		$ 130	
P.E.C.E.	433		173		52	
General Expense	1,000		450		75	
Total	$2,992		$ 1,372		$ 257	
Contribution Margin	$8,062	32.3%	$ 4,042	40.4%	$1,645	54.3%
Breakeven Point						
Amount	$9,260		$ 3,400		$ 470	
Percent Capacity	37%		34%		16%	
Investment	Fixed	Variable (% Sales)	Fixed	Variable (% Sales)	Fixed	Variable (% Sales)
Manufacturing Plant	$6,000	-0-%	$ 3,200	-0-%	$ 500	-0-%
Inventories	130	5.2	30	4.6	10	3.2
Receivables	-0-	8.3	-0-	8.3	-0-	8.3
Cash	244	5.7	112	5.0	21	3.8
Total	$6,374	19.2%	$ 3,342	17.9%	$ 531	15.3%
Reserves						
Plant	$1,800	-0-%	$ 960	-0-%	$ 150	-0-%
Inventories	23	0.3	5	0.3	2	0.2
Other	-0-	0.3	-0-	0.3	-0-	0.3
Total	$1,823	0.6%	$ 965	0.6%	$ 152	0.5%
Accounts Payable	175	1.9	55	1.5	16	1.4
Total-Reductions of Investment	$1,998	2.5%	$ 1,020	2.1%	$ 168	1.9%
Net Investment	$4,376	16.7%	$ 2,322	15.8%	$ 363	13.4%

* Data for Product Lines C and D omitted.

activity unit, he can readily calculate exactly what he will be charged in any given period for service expense. Further, having this knowledge, he is satisfied that any variance generated by inefficiencies of service sections

will show up on the operating reports against those sections. This change has meant that accurate profitgraphs by product line could be built and used.

It will be recalled that the type of business is that of component manufacture similar to that of the plastics industry, made up of four product lines and each having substantially different manufacturing processes but with common service facilities such as power, maintenance, production, financial, etc. The cost data applicable to the over-all operation already shown in EXHIBIT 3, is given a finer breakeven analysis in order to construct profitgraphs by product line. This results in EXHIBIT 6. It will be noted that investment as well as cost has been broken down in detail and between fixed and variable elements. This procedure makes it possible to construct sound profitgraphs by product line and for any product-mix within a plant. Using this analysis data profitgraphs have been constructed for each product line within the plant. EXHIBITS 7 to 10 reflect the graphs constructed for each line. EXHIBIT 7 reflects a healthy type of business and operation. Analysis of fixed costs would be in order to find ways of improving return at 60 per cent of capacity. EXHIBIT 8 is the graph of a highly desirable business condition. However, the higher return and gross margin could represent a danger sign, in that the business might be lucrative for others to enter. The picture in EXHIBIT 9 would seem to reflect an old established business, with a high material content and, perhaps, a very competitive situation. It calls for a sound review of product, process,

EXHIBIT 7

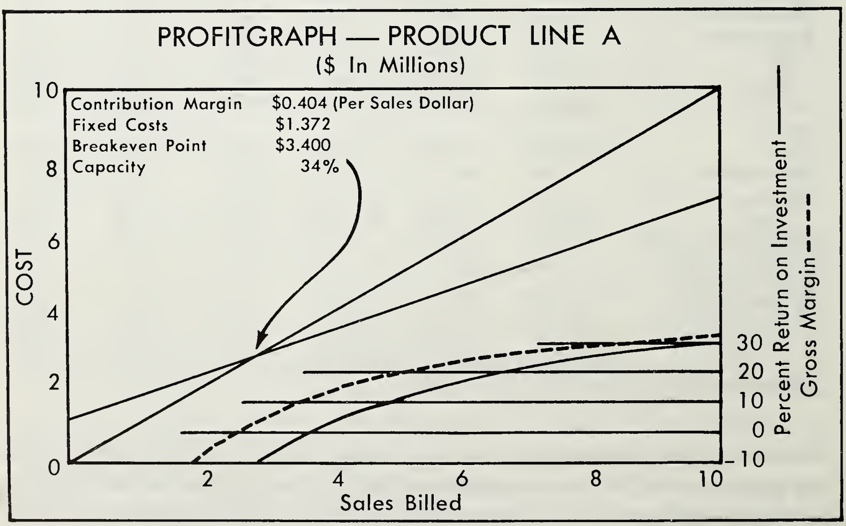
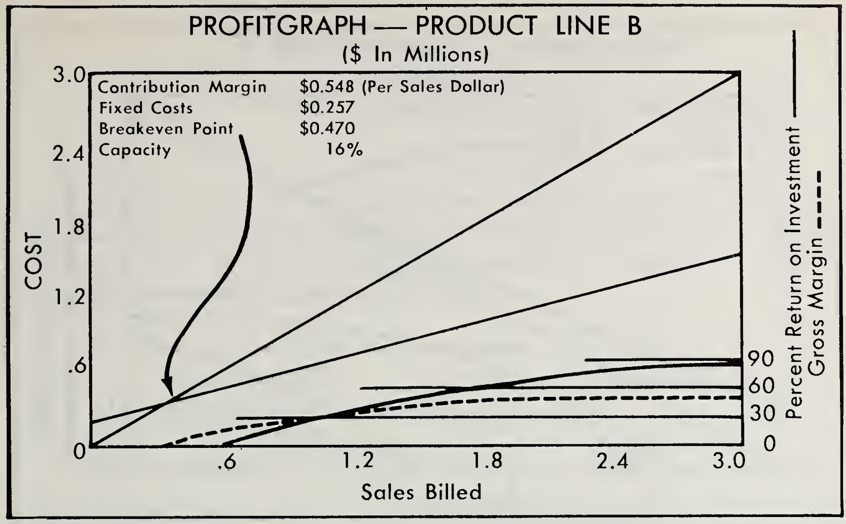


EXHIBIT 8



equipment, and organization. The EXHIBIT 10 profitgraph indicates a very undesirable state of affairs, a business operation that should be disposed of quickly, in all probability.

EXHIBIT 9

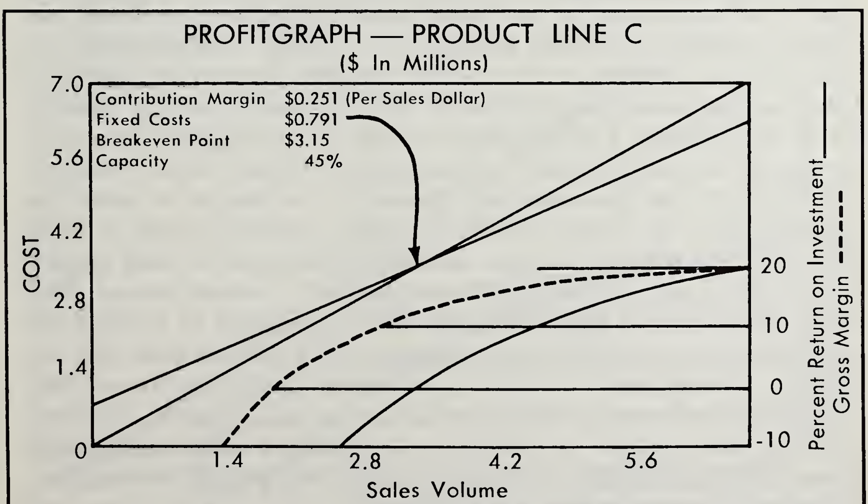
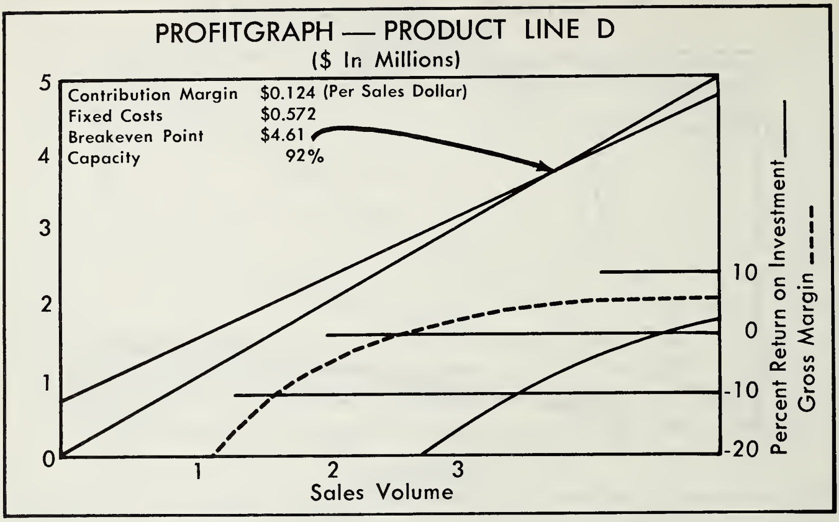


EXHIBIT 10



We come now to determination of profit contribution by broader areas. Whenever general discussions of breakeven analysis have been held, there have been wide differences of opinion as to the value of breakeven charts and profitgraphs for projections made on a broader scale than a basic operating unit such as a plant. It has been constantly pointed out that these guides are constructed on too many expected conditions and with one specific product or sales-mix. Profitgraphs may be prepared for plant, department and division, in that order. But top management, generally, places only nominal value on those for the departments and little value on those for divisions. The reasoning has been that profitgraphs have progressively less value as they are projected to broader units. However, working with the procedure just illustrated it is possible to revise the profitgraph to factor any desired or forecast product-mix and to make this revision quickly. In the same manner, revisions can be made quickly for changing price or cost patterns. Further, such revisions become practical and accurate so long as the basic data accumulated by product line and productive cost center are maintained on a current basis. For example, referring back to EXHIBIT 3, the initial profitgraph shown here, which is based on an assumed product-mix equal, ratio-wise, for each product line, it might be well here to construct a revised profitgraph based on a radically different product-mix. For this purpose, we could assume the following product-mix:

Product Line		*Per cent of Total Sales*
A		48%
B		12
C		27
D		13
—	Total	100%

Employing the breakeven analysis data detailed on EXHIBIT 6, the construction of a profitgraph based on the changed product-mix is readily facilitated. The revised profitgraph is shown on EXHIBIT 11. Major changes over the original profitgraph are:

	From	*To*
Breakeven point	$9,260,000	$8,723,000
At capacity		
Gross margin	26.3%	28.3%
Return on investment	28.4%	31.6%

With sound breakeven analysis data, there should be no reason why accurate profitgraphs cannot be built for broader areas (department, division, etc.) and their value "sold" to top management.

EXHIBIT 11

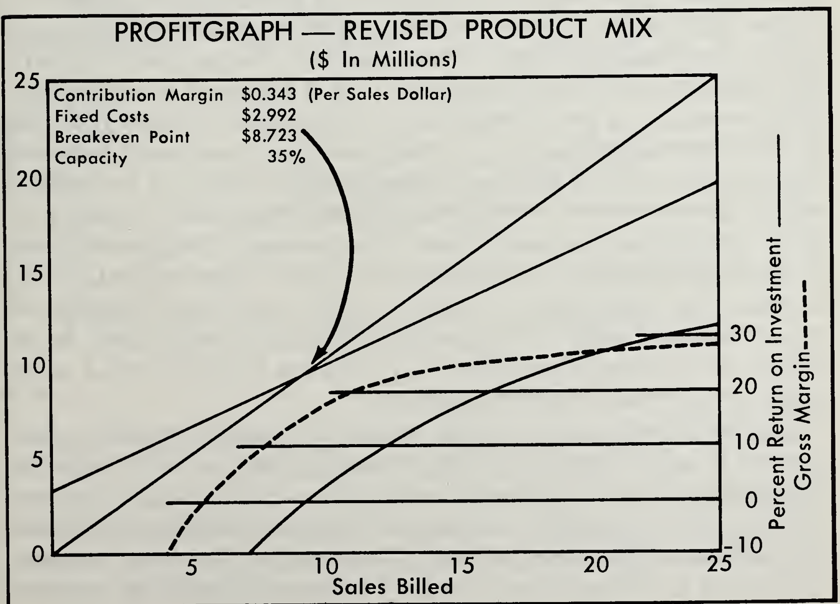
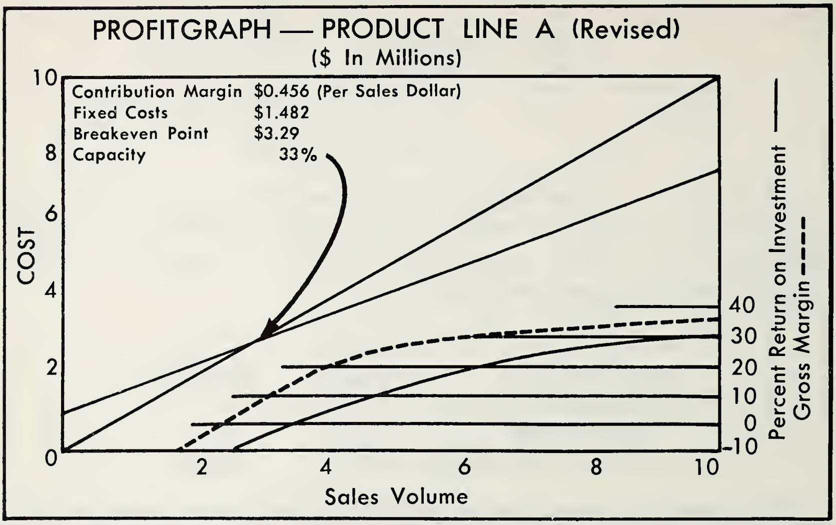


EXHIBIT 12



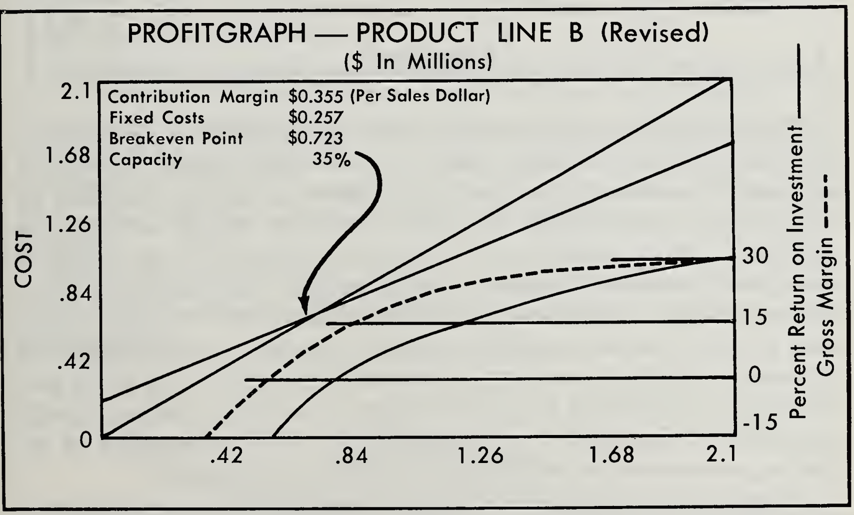
Decision making on automation is gaining in importance. As in the instance of pricing, it is often necessary for management to make decisions as to whether to go further with integration or automation. In such instances, profitgraphs represent valuable guides in projecting the changed profit patterns under alternate courses of action. For purposes of illustration, take Product-Line *A* (EXHIBIT 7) which represents a high volume, good potential, and price-settled item. It is proposed to invest $1,000,000 in new capital equipment for it. If expended, it is estimated that there will be labor savings of $400,000, savings in waste of $90,000, and net savings in factory overhead of $30,000, in spite of the added operating expense (savings based on capacity sales of $10,000,000). The question, then, is: With annual variable cost savings of $520,000, increased fixed costs of $110,000, and added capital investment of $910,000 (after inventory and cash reductions), what will the profitgraph indicate with respect to the wisdom of this move? Conclusions may be drawn from the revised profitgraph for the product shown in EXHIBIT 12.

The third specific area is decision making for pricing. Frequently, management is faced with the problem of making a decision with respect to the pricing of a product. It may be one of short-range or long-range consequence. If it is the latter, management must know the effect of alternative decisions which might be made. Would the decision leave the product line still profitable? Should the line be dropped? Should the company

"go after" more volume to capture the former profit dollars, etc.? These are some of the questions often asked. Further, there are the situations in which a new product is being brought out and management needs guidance on the price that will result in a healthy operation.

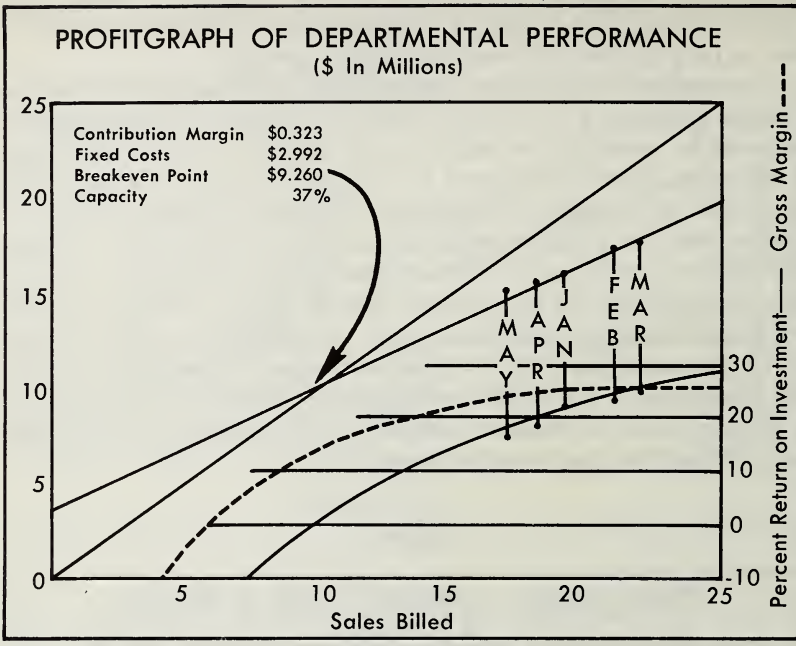
In connection with problems such as these, profitgraphs can be of considerable assistance. For example, looking at Product Line *B* as it has been presented in EXHIBIT 8, we find a very profitable item from every angle of evaluation. However, this may be a temporary situation brought about by a "first" in the market or a demand well ahead of capacity. What will happen when this picture changes and management must make a decision with respect to new price levels and, perhaps more important, the question of continuing this line. Assume that all of the advantages available will expire within the next few months. Competition is coming out with a price level averaging 30 per cent below the current level. If the company follows suit, what would the profitgraph for Product Line *B* look like. A revision based on breakeven analysis data on EXHIBIT 6 would change this profitgraph to that shown in EXHIBIT 13.

EXHIBIT 13



What should management do with this picture in mind? It has several choices. Much would depend, of course, on the market potential, cost reduction possibilities, etc. In any event, the profitgraph technique will be of value in any decision making along this line. Similar projections can be made in broader areas of operation, in the elimination of product lines, in the integration of production, etc.

EXHIBIT 14



The final specific area to be dealt with is measurement of performance. Obviously, the most effective control is that which is finer or closer to the actual expenditure, than other means. Direct material is controlled by area, as net, waste, spoilage, etc.; direct labor by element such as pure productive, set up, rework, etc.; and factory overhead by the nature of each item of expense through the variable budget. This close type of control is essential in today's competitive situation in order to keep current costs in line. However, management needs a broader type of measurement by means of which it can quickly obtain a picture of over-all profit performance in relationship to projected goals or forecasts. The profitgraph represents an ideal answer to this requirement as it is susceptible of reflecting measurement of performance in any area of operation.

In some units of the operation used for illustration here, monthly profit performance is recorded on an enlarged profitgraph, with smaller copies being made and distributed to specific members of management. This practice presents an excellent picture of profit performance trends and makes a very positive impression on those charged with the responsibility of profit production. With a knowledge of performance under the variable budget and other cost controls, supervisors can quickly grasp the effect of their variance from tight control. An example of the type of profit performance measurement is supplied in EXHIBIT 14.

51. GUIDES TO INTERNAL PROFIT MEASUREMENT

Gordon Shillinglaw*

The author discusses the information which is relevant to evaluating and also stimulating the level of performance of internal units into which the company can be divided. The specific manner in which accounting data must be assembled for this purpose is also discussed.

The president of a large machinery company recently asked two staff executives to evaluate the profit performance of one of the company's operating divisions. Using the identical accounting information, both men proceeded independently to work on the assignment. One submitted a report showing a $1 million profit for the preceding year; the other indicated a $2 million loss.

The completely divergent conclusions in this case, though admittedly extreme, serve to point up the wide differences of opinion on how to measure the profit performance of individual units within a multi-unit company. What it boils down to is that there is no single definition of "profit" to which all subscribe.

The problem is as elusive as it is difficult. A survey of accounting literature discloses widespread variety in the solutions recommended. The literature in economics is less extensive, presumably because many economists tend to regard the firm as a single profit-maximizing entity. And published descriptions of company practice are rare indeed, which means that some of the best industrial thinking on this problem is publicly unavailable.

The purpose of this article is to discuss some of the issues in profit performance measurement and to provide a framework for further analysis of the problem.

USEFUL PURPOSES

Internal profit reports serve a number of useful purposes. Probably the most important are:

1. As a guide to current operating or "tactical" decisions.
2. As a basis for evaluating managerial performance.
3. As a basis for profit trend and profit variance analysis.
4. As a starting point for long-range investment decisions.

* From *Harvard Business Review,* XXXV, 2 (1957), 82-94. Reprinted by permission of the *Harvard Business Review.*

Because of the number of uses to which profit data are applied, many different kinds of reports are prepared. Some are routine by-products of the normal accounting procedure; others are developed on request, but still on the basis of balances shown in various accounts. Another group of reports derives from special analysis, generally probing beneath the surface of the accounts and frequently modifying the basic accounting information.

In this last group are found the profit reports used to guide investment and disinvestment decisions, such as:

Should a new refinery be built on the East Coast?
Should the container plant be sold?
Should a sports coupe be added to the line?

Examination of these alternatives calls for long-range economic valuation and profit projections extending many years into the future. Although past profit data provide a starting point for these investigations, final decisions are based on analytical concepts that differ materially from those embodied in the historical accounting records. For this reason, routine periodic profit reports are neither wholly relevant nor fully necessary to serve the purposes of long-range investment analysis.

ACTION AND EVALUATION

The profit reports with which we are concerned in this article are not special analyses; they are, rather, the routine periodic earnings statements which are generally prepared once a month. The typical report of this kind is intended mainly for use as a guide to action and evaluation. For example:

Should one product line be pushed instead of another?
Is the management of the export division showing an adequate profit contribution?
Does added volume justify particular price concessions?

These applications are immediate and short range; for questions of this sort the time horizons are relatively short. Also, significant profit differentials are often relatively small.

PROFIT AND SERVICE CENTERS

The need for measuring the profit performance of subordinate executives arises wherever management responsibility is decentralized—that is, delegated to semiautonomous profit centers. It does not exist in a monolithic organization where major economic decisions are made only at the top. Autocracy removes the unit manager from direct control over most of the factors that determine profit. Under these conditions the company

as a whole is the only unit for which profit measures are meaningful; the performance of subordinate executives must be judged on how well they carry out top-management decisions, not on unit profits.

When management is effectively decentralized, however, the unit manager is expected to run his portion of the enterprise as a semiautonomous business. He does not, of course, control his own capital budget, since the internal distribution of investable funds is always a top-management responsibility. But the division manager does exercise a wide range of powers and make numerous important policy decisions. In many cases, for example, he—

Determines selling prices.

Makes the operating decisions on manufacturing methods and personnel requirements.

Selects distribution channels.

Chooses his sources of supply.

In short, he has primary responsibility for most of the major determinants of profit. Under these circumstances, profit provides a meaningful measure of the unit manager's achievement. In fact, a reliable measure of profit performance is absolutely essential to effective decentralization and autonomy at the division level.

This is not meant to imply that profit is the only measure of executive performance. Other factors enter in, such as the manager's willingness and ability to select and develop subordinates, his ability to maintain harmonious labor and community relations, and his capacity to handle organization and communication problems. Appraisal on these grounds requires informed judgment that is at least partially independent of profit data. Without denying the importance of these other factors, however, the present discussion concentrates on the one aspect of performance, *profit achieved.*

SERVICE UNITS

All activities in a large decentralized company cannot be organized as profit centers. Always some are organized as service centers. The relationship of these with other company units is such that profit cannot be used either to guide action or to measure achievement.

A service center is a unit organized primarily to perform a service for or supply goods to other units in the firm. These goods or services are transferred at "full cost," "cost plus," or some other arbitrary "price"—perhaps even at no charge at all. The service center provides all the goods and services demanded of it internally, up to the limit of its capacity. It cannot refuse to perform its functions solely because the "price" that it charges other company units is too low. Accordingly, the financial performance of service center executives is judged not on profit but on the

basis of how closely its costs adhere to the amount budgeted for the level of activity *achieved.*

The classification of units into profit centers and service centers is not based on a set of rigid "principles." Activities that in one company are defined as profit centers will be operated as service centers in another. It is largely a matter of individual choice among organizational alternatives. For example:

In one large food processing company the print shop is organized as a profit center. It is judged on the basis of how much profit it is able to make each year on the items it prints on order for other units of the company.

In most companies the print shop would probably be classified as a service center, or lumped with other units in some larger organizational grouping—e.g., the manufacturing division.

CHOOSING A MEASURE

Routine profit reports, as previously noted, are mainly used as guides to managerial decisions and as measures of managerial performance. Of these two uses the first is more fundamental. Appraisal, after all, is based on performance and is largely a matter of comparing achievement with predetermined standards.

TWO REQUIREMENTS

Since there are several profit concepts that might be considered useful for guiding and measuring profit center managers, it is important to decide what criteria any such profit measure should meet. Two stand out as especially important—one imposed largely by the fact that the measure is used for purposes of evaluation, the other imposed because the measure is used as a guide.

For Evaluation. The first major criterion is that the profit by which a unit is *judged* must be independent of performance efficiency and managerial policy elsewhere in the company.

This requirement is essentially a problem of *separating* the earnings of one profit center from the earnings of another. This is not particularly easy to do, especially in companies large and complex enough to be organized into profit and service centers. In such organizations an individual profit unit depends to a large extent on other profit and service centers. Hence the financial results it achieves are hard to segregate entirely from the results achieved by others. For example:

Motive power, maintenance, market research and general company administration activities are among the services often used jointly by several profit centers.

Semimanufactured goods and by-products are often transferred among profit centers.

The efficiency with which these goods are produced and these services performed is not under the control of the profit center manager. He should get no credit for a job well done by other units, and no blame for another unit's failure.

Under these conditions, separation of earnings can only be achieved by an adequate solution to the transfer-pricing problem. Since this whole area will be considered in more detail later, it suffices to make only two key observations at this point:

To the extent that the profit center manager can control the quantity of goods and services used by his division, he should be charged for them.

The unit price charged should not depend on "actual" cost efficiency in the profit centers or service centers from which services and goods are secured.

As a Guide. The second major criterion is that the profit by which a unit is *guided* must be such that an increase in reported divisional profit cannot be achieved by any action that drives total company profit down.

It is easy to see why divisional profit should at least point in the same direction as company profit. The principal danger of a poorly designed profit measure is that it might lead a unit manager to increase his own reported profits by actions that did not help the whole company. This danger is real—for example:

In one company, general office charges were allocated to divisions on the basis of relative sales volume. Faced with a declining market, the manager of one division decided to hold the price line and accept the resultant volume loss. This decision cost the company more than $1 million in profits during a nine-month period, but the division's operating statement showed only a slight decline in profit for the same period.

The profit performance measure was clearly at fault here. No division manager can be expected to ignore the effects of his decisions on his reported profit if this is to be a basis for appraising his performance, no matter what the effect on total company profit is likely to be.

FOUR PROFIT CONCEPTS

How should profit be defined to meet the requirements of an adequate measure? Four major alternative concepts must be examined to answer this question:

1. *Sales margin,* or total revenues less total variable costs to make and sell.

2. *Controllable profit,* or sales margin less all the division's controllable fixed costs.

3. *Contribution margin,* or controllable profit less all other costs directly traceable to the division.

4. *Net profit*, or contribution margin less some share of general management and service center costs.

In EXHIBIT I, each of these four concepts is illustrated. For discussion purposes, they can be examined most conveniently in reverse order.

EXHIBIT I. FOUR PROFIT CONCEPTS

Sales	$760,000
Variable cost of goods sold	270,000
Variable divisional selling and administrative expense	30,000
Sales margin	$460,000
Controllable divisional overhead	200,000
Controllable profit	$260,000
Fixed, noncontrollable divisional overhead	150,000
Contribution margin	$110,000
Allocation of extradivisional expenses	50,000
Net profit before taxes	$ 60,000

NET PROFIT

Since the performance of the company as a whole is judged on the basis of net profit, it might appear logical to judge profit centers on the same basis.

Unfortunately, logic breaks down at this point. Net profit is the least useful of our four profit concepts. Its usefulness for both evaluation and guidance is destroyed by the arbitrary allocations of extradivisional expenses that must be made in order to derive a net profit figure:

> These allocations make true earnings separability impossible because they make the total amount charged to the division dependent on efficiency or policy decisions outside the division. For example, an increase in the president's salary or in the appropriation for institutional advertising reduces the reported profit of each division.
>
> If these allocations of external costs are made on the basis of some index of activity—such as number of employees or sales dollars—the division manager will be tempted to regard these fixed company overhead charges as part of his variable expenses. If this mistake is made, operating decisions may be distorted. For example, the use of sales volume as the basis for cost allocations assumes that general expenses will increase or decrease in direct proportion to sales. Operating under this allocation method, a division would refuse to expand its sales unless the added revenue would more than compensate for the increased allocation of general expense. But this same increase in sales volume might actually increase total company profit if the actual increase in general expenses was less than the allocated amount.

Some will object to the description of cost allocations as "arbitrary," arguing that if the method of making them is carefully selected, allocations can be equitable. As an executive of one of the large rubber companies recently put it, his company "does not believe in anything short of net profit" because each division "must bear its fair share" of general expenses.

This merely substitutes one problem for another. How can we determine what share is fair? Two allocation methods will distribute general expense among divisions in entirely different proportions. To the extent that a cause-and-effect relationship can be found between the expense and the divisional activities, some cost assignment may be justified—provided it is made at a predetermined price. Most general expenses, however, cannot be traced to the activity of a single division in this way. They are "common costs" incurred for the joint benefit of several company units. This means that any allocation of these costs is arbitrary, no matter how "scientific" the process by which the allocation rule is determined.

Management may, despite these objections, decide to assign general expenses to profit centers, perhaps on the ground that the division head should be made aware of their existence. If so, these costs should be entered at the bottom of the profit center's performance statement, as in EXHIBIT I. It should also be made clear that they do not affect the evaluation of divisional efficiency.

Even with this precaution, however, there is some danger that the division manager might tend to treat these expenses as varying with some index of activity. To combat this possibility, the amount charged to a division should be *a lump sum, preferably determined in advance*, and thus independent of variations of "actual" from budgeted amounts.

CONTRIBUTION MARGIN

Using contribution margin as the measure of performance avoids one of the errors involved in using net profit. It recognizes the arbitrary nature of the allocation process and excludes any prorations of extradivisional fixed costs. However, it does deduct divisional fixed costs from sales revenue.

But once the purposes of routine profit reporting are recalled, the case for contribution margin, as herein defined, also falls apart. Some divisional fixed costs are noncontrollable, and hence they should not enter into the evaluation of management's performance. For example:

Certain fixed costs imposed on the division by top management or by decisions of prior years, such as the division manager's salary, depreciation, property taxes, and insurance, are not currently controllable at the division level.

Although some of these uncontrollable fixed costs (depreciation and property taxes, for instance) reflect the past investment decisions of management,

and thus throw light on its over-all record, this aspect of performance is much more effectively appraised through special reviews of capital outlays than it is through the current data on profit performance.

If contribution margin fails as a measure for purposes of evaluation, it also falls short as a guide to action. Noncontrollable fixed costs are all "water under the bridge," and hence have no proper place in shaping management's current operating decisions.

The use of contribution margin as a profit measure may stem from confusion as to the proper purpose of routine profit reports. If these were useful as guides to investment, then this profit concept might appear defensible on the grounds that it reveals divisional earnings after deduction of all costs directly traceable to divisional activities. But, as pointed out earlier, the purpose of routine profit reporting is not to answer long-range investment questions. Even if it were, contribution margin is an extremely incomplete indication of investment profitability. The purpose of the routine profit report is to guide and appraise the performance of division executives, not to say whether the activities entrusted to them are, in the aggregate, profitable or unprofitable.

For the sake of completeness, management may wish to show noncontrollable fixed costs on the division's profit report, as illustrated in EXHIBIT I. If so, they should be treated in the same way as the extradivisional cost allocations discussed in the previous section; that is, it should be made clear that they do not enter into the evaluation of current performance. Division managers should be educated to resist the temptation to prorate these costs to production and/or sales by some percentage factor, thus mentally converting them into variable elements that will influence short-run decisions.

CONTROLLABLE PROFIT

The next concept to consider is the measure of the profits over which the division manager can assert direct control. This is what is left after deducting from sales revenue all variable costs plus those "fixed" costs which can be controlled by the profit center manager. In this sense, controllable profit is a hybrid. While the variable costs to make and sell are the sum of the specific costs for the *individual* products or product lines, the controllable fixed costs are joint costs to *all or several* of the products of the profit center, and include such items as engineering, design, supervision, and sales management salaries.

Although controllable fixed costs are not entirely relevant to tactical or operating decisions, collectively they make up an area in which the division manager can exercise control through customary budgetary procedures.

More significant, these fixed or joint cost elements are also controllable by action. The division manager can increase or decrease the scope or nature of the various joint cost activities in an effort to find the most

EXHIBIT II. PRODUCT MARGIN AND SALES MARGIN

	Product A		*Product B*		*Total division*	
Sales		$304,000		$456,000		$760,000
Variable cost of goods sold	$145,000		$125,000		$270,000	
Variable selling and administrative expense	12,000		18,000		30,000	
Total variable expense		157,000		143,000		300,000
Product margin		$147,000		$313,000		
Sales margin						$460,000

profitable mix. For instance, a high level of fixed costs might permit a low level of variable costs, or vice versa. Again, new procedures may be introduced to reduce bookkeeping costs, or the design staff may be increased and the process engineering staff cut back, or a preventive maintenance program may be introduced, if this will increase the company's profits.

Although these decisions are different from the daily operating decisions regarding price, product mix, input combinations, and so forth, there is considerable merit to the argument that these controllable fixed costs should be included in the profit performance measure.

SALES MARGIN

The least inclusive of the four profit concepts, sales margin, is also the least ambiguous. It avoids arbitrary cost breakdowns and includes only those costs that are functionally related to the volume of sales. The profit effects of a change in product mix or in price will be reflected immediately in the sales margin figure.

Sales margin is the *sum* of the incremental profits produced by each of the division's products. As such it provides the division manager with a useful guide to action, and it also provides top executives with a similarly useful basis for evaluation:

In the division, questions of sales emphasis, product mix, and the like can frequently be settled by reference to incremental profit figures drawn up on a product or product-line basis.

At headquarters, sales margin—since it is the total of product margin figures—is a highly sensitive measuring rod of the effectiveness with which the profit center makes its current operating decisions.

The relationship between product margin and sales margin is illustrated in EXHIBIT II. In this example each dollar of sales from Product *A* is contributing much less to company profit than is each dollar of sales from Product *B*. With this information to guide him, the division manager can formulate and analyze his principal alternatives:

1. He can investigate the possibility of increasing selling effort on Product *B*, considering both the market possibilities and the added costs necessary to secure added sales.

2. He can also investigate the possibility of changing design specifications or methods of manufacturing Product *A* in order to increase its product margin.

To the extent that the manager's efforts are successful, they will result in an increased total sales margin for his division, and an increased profit for the company as a whole.

NO "BEST" CONCEPT

No one of the four profit concepts is "best." None is superior for all purposes. To illustrate more specifically:

For profit trend analysis, it seems to me that contribution margin, controllable profit, sales margin, product or territory margin, and so forth, all have a role to play.

For long-run investment-type decisions, some broader concept akin to contribution margin has some relevance; but for these purposes historical accounting data must in most cases be modified and adjusted considerably.

Even for the two purposes with which this article is mainly concerned, no single concept quite fills the bill:

For evaluating executive performance, the presumption is in favor of controllable profit.

As a guide to relatively short-range decision making, which is probably the most important single use of reported profit data, both controllable profit and sales margin usually need to be considered.

Many short-range decisions require a somewhat broader view of costs than sales margin alone provides. Many such decisions require comparisons, not just among alternative aggregates of product margins but also among alternative combinations of controllable "fixed" costs.

While it may at first seem a contradiction in terms to speak of *different* fixed costs, this difficulty disappears as soon as it is recalled that the term "fixed" is far too narrow to be absolutely accurate. Certain costs that are

fixed in relation to small changes of volume may vary when larger changes are involved. For example, a major shift in product emphasis may entail additional advertising and salesmen, even a larger office force if the move is successful. In short, cost variability has other dimensions than the sales margin concept assumes.

These considerations argue for the use of a *composite* profit concept, with controllable profit as the basic measure of performance but supplemented by supporting data that will provide sales margin information for the division manager. A profit report using this concept is illustrated in EXHIBIT III.

EXHIBIT III. DIVISION PROFIT REPORT

	Product A	*Product B*	*Total*
Sales	$304,000	$456,000	$760,000
Variable costs	157,000	143,000	300,000
Sales margin	$147,000	$313,000	$460,000
Controllable fixed costs traceable to product	20,000	30,000	50,000
Contribution margin	$127,000	$283,000	$410,000
Other controllable fixed costs			150,000
Controllable profit			$260,000

This kind of report has the merit of providing a flexible tool for the division manager. Each item in it is subject to his control. By projecting the probable effects of his decisions on each item, he can have a clear-cut guide for current operations, and he can apply to each operating problem the profit concept that is most relevant to its solution.

One danger remains, however. Inasmuch as we have included in the statement costs that are "fixed" but really controllable, there may be some tendency for the division manager to regard these costs as *fully* variable and tied by some kind of percentage relationship to volume. This danger can be minimized by:

Fostering a complete understanding of the basis on which the cost classifications are drawn.

Demonstrating to the division managers that such a practice will not improve their reported profits.

Any danger that remains must be accepted as the necessary price of including in the profit report those "fixed" costs that are relevant to current operating decisions.

RECORDING COSTS

Devising an accounting system that will generate sales margin and controllable profit figures is not a task to be approached lightly. Three types of problems must be faced: (1) designing an appropriate classification system for *recording costs;* (2) providing a means for realistic *cost analysis;* and (3) arriving at a satisfactory system for determining *transfer prices.* In this section let us look at the job of setting up a suitable classification system, and then go on to the other two problems in the next two sections.

ACCOUNT CLASSIFICATION

Since one use of cost data is to permit the reporting of controllable profit, initial cost recording should follow the pattern of the organization structure. That is, when a cost is incurred, it should be charged directly to the organization unit whose manager is responsible for incurring it. The controllable costs of each unit—whether it be a profit center, service center, or section of the central office—can then be read directly from account balances.

The same principle can also be applied *within* a profit center. For example:

> Each foreman in a manufacturing plant might receive periodic reports listing the costs for which he is responsible. The total costs incurred by the foreman can then be compared with budget allowances to see how closely he is controlling costs in his jurisdiction.
>
> The degree of refinement in the breakdown of costs within a profit center will depend on the organization and control mechanisms used by the profit center.

Since this cost recording system ought to serve as many uses as possible, even those costs that cannot be controlled by the unit managers ought to be assigned to the organizational unit. These would include such items as property taxes, property insurance, and noncontrollable depreciation charges.

Such an assignment of noncontrollable costs would be unnecessary if the cost records were used exclusively for purposes of profit measurement. Their role, however, is not so limited; for example, management should take them into account in making activity-abandonment decisions and in making valuations and reports for tax purposes. Such purposes as these may require organizational identification of noncontrollable but traceable costs.

BREAKDOWN BY FUNCTION

Within each organization unit costs should be further classified according to their function. That is, one set of accounts might be related to the selling function, another set might pertain to the manufacturing function, and so forth. This is necessary to permit *analysis* of functional costs.

Three important questions arise in regard to this functional classification:

1. *How fine does the breakdown have to be?* Here two considerations must be weighed against each other—cost versus accuracy. The finer the initial cost breakdown, the more expensive, for it obviously is more difficult to classify every cost as to product line, territory, salesman, customer account, etc., than it is to make the initial recording in terms of product line only. Also, the finer the initial breakdown is, the greater the chance of clerical misclassification. If a broad classification is chosen, however, a certain amount of accuracy is sacrificed, although it is still frequently possible to obtain more detailed information by either working back to original cost documents or making approximations.

2. *In the case of costs jointly incurred by two or more segments of the unit, how complete a cost distribution must be made?* The main consideration is the practical problem of making a valid assignment. The finer the attempted breakdown, the more costs will have to be thrown into a common pool because of the difficulty of identification. For instance, a salesman's salary may be fairly definitely assignable to a given product line, but it may be impossible to assign that salary to a given customer in any meaningful way. This circumstance should not be interpreted to mean that functional breakdowns should be kept to a minimum. Rather, management should recognize the existence of common costs within the organizational unit and should design its accounting system accordingly. A relatively fine functional breakdown is obviously much easier to achieve for companies having separate sales forces and separate manufacturing facilities for individual product lines than for companies having many products that are all sold through a common sales force.

3. *In how much detail should the costs of each function be accumulated?* Here economy versus ease of analysis is once more a key issue. To achieve greater detail clerical costs must be increased. Thus a balance must be achieved between a large number of accounts, each internally homogeneous, and a small number of accounts, each having a total balance that may obscure underlying cost relationships and make cost analysis more difficult.

In short, the functional classification of costs will depend upon three main factors: (a) the nature of the organization, (b) the cost of operating

the accounting system, and (c) the frequency with which detailed cost analyses are called for.

To the extent that different functional activities are combined in a single cost category, the basic records should be kept available in a form that will permit special analysis whenever it is necessary to determine how profitable any one of the combined segments has been.

COST ANALYSIS

Given a sound cost recording system, management's next need is good cost analysis. Raw cost data, classified by organization and function, may need further processing to permit the development of sales margin and product margin figures, preparation of flexible budgets, special profitability studies, and so forth.

If measures of profit performance are to serve as guides to action, several steps are necessary in converting raw cost data to usable form:

All actual costs should be adjusted to their current levels.

Where standard cost systems are in use, the treatment of variances must follow a special pattern, different from the pattern followed in preparing the published financial statements.

The importance of distinguishing between fixed and variable costs means that studies must be run to determine which cost elements vary, and how, with the level of activity.

CURRENT COSTS

Operating decisions should be based on balancing *current* revenues against *current* costs. The actual recorded costs incurred will not serve the purpose, for their relevance is too often impaired by changes in the prices of labor, materials, and service.

It does not matter, for example, that inventories were acquired last year at $1 per unit. What matters is that replacing a unit of inventory today will cost $1.50; this is the cost relevant to price, product promotion, and other decisions. Particularly where inventory turnover is slow, the use of a FIFO basis for inventory valuation may prove a poor guide to decisions.

VARIANCE TREATMENT

Use of a standard cost system should prove no bar to profit measurement, provided the standards are kept reasonably current, and provided also that variances are properly handled. Quantity and efficiency variances for labor, materials, and variable overhead should be charged or credited to the division in the normal accounting procedure. But, for reasons already given, year-end adjustments to restate inventory values in conformity with methods used for financial reporting should not be included in the measure of profit performance.

This solution is open to apparent objections on two scores, but these objections can quite easily be answered:

1. Admittedly, the proposed treatment of inventory overlooks one dimension of divisional executive performance that top management will wish to appraise: If an executive has a record of consistent losses on obsolete inventory, or writedowns to bring inventory in line with current replacement costs, this is evidence that all is not as it should be. Such a deficiency would not show up in the profit measure I am advocating; in fact, if the market price of items in stock should fall, the division's profits under the proposed system would appear *greater* because of the lower cost charged to the goods sold.

However, at the end of the year inventory losses or write-downs would show up in the usual financial reports. When this happens, top management could find the explanation readily by referring to the operating records of adjustments in inventory values. It would see what inventory prices had fallen, when, and by how much. It would be in an excellent position to analyze the record and to assess the division management's responsibility for it.

2. Admittedly, also, any system that departs from the accounting methods used to derive published financial statements may involve a company in fairly substantial end-of-year adjustments to its interim financial reports. These adjustments, it is claimed, can frequently be large enough to turn what looked like the makings of a highly profitable year into a "loss."

But this objection overlooks the fact that the report of profit performance is intended for management use only; since it need never have its way into public print, it need never cause public confusion. Furthermore, if the accounting adjustments necessary to convert the performance measure into a published financial report are made frequently enough (they need not be complex), it is unlikely that management will be jolted by unforeseen results at the annual closing.

FIXED AND VARIABLE

Since the profit measure can only function as a guide to action and evaluation if noncontrollable costs are excluded, it becomes essential to isolate the noncontrollable cost elements. Difficulties arise, usually in connection with overhead expenses. Once fixed overhead elements have been identified, it is generally not hard to distinguish the controllable components. Indeed, this can usually be done on the basis of inspection of the accounts. But the initial step of distinguishing between fixed and variable overhead is not so easy.

Careful studies of cost behavior are necessary to accomplish this purpose. It is not enough to *assume* that a certain cost element will vary in a

given way with the level of activity; statistical and engineering studies should be made to *determine* this relationship, insofar as possible. Such determinations should be kept up to date by a scheduled program of routine checks of past data and forecasts of future performance.

Segregation of fixed from variable costs will be facilitated by adoption of "direct costing" as the basis for manufacturing accounts. As pointed out in a recent article which appeared in this magazine:

> In direct costing, only the direct [variable] costs are charged to inventories and to cost of sales. All period [fixed] costs are charged to profit and loss in the period in which they are incurred or accrued.[1]

It is not the purpose of the present article to evaluate direct costing. But it should be pointed out that direct costing makes it possible to get figures for manufacturing costs that are meaningful for profit measurement. Analogous procedures can do the same for variable costs of distribution and administration.

TRANSFER PRICING

Now let us turn to one of the most interesting problems of all—the "pricing" of goods and services which are transferred from one company unit to another. Transfer pricing would be simple if profit centers were independent and separable. In truth, of course, they are not. The finished product of one division or subsidiary is frequently the raw material of another (an especially common situation in integrated corporations). Moreover, some service functions are centralized and deal with a number of profit centers. Both facts sometimes complicate the pricing problem seriously.

TRANSFERS OF GOODS

When transfers of goods are made, a portion of the "revenue" of one profit center becomes a portion of the "cost" of another. Thus the price at which transfers are made can influence the earnings reported by each profit center. For example:

> The export division of a large eastern manufacturing concern showed substantial gains in sales and profits during 1954. Profits of this company's largest domestic division were disturbingly low during the same period. It turned out that the export division had been "buying" large quantities of manufactured

[1] Roger Wellington, "Direct Costing and Its Implications in Financial Reporting," *Accounting, Auditing, Taxes 1953* (New York, American Institute of Accountants, 1954), p. 56; quoted by Donald G. Mackenzie, "Looking Around," *HBR* January-February 1957, p. 148.

goods from the domestic division, these goods being transferred on the books at standard manufacturing cost. In order to meet production schedules, the domestic division had purchased a substantial part of these requirements from outside vendors at higher cost. Thus the transfer price system in effect here gave the export division a subsidy at the expense of the domestic division.

In another company, one division processed and sold the by-product of another. The first division obtained this material on the basis of a price formula which, in effect, guaranteed it a fixed gross margin. Under this formula, a drop in the market price for the processed by-product caused an automatic reduction in the transfer price of the material. The by-product division consistently showed a handsome net profit whereas the supplying division had a spotty record of fluctuating profits.

Transfer price systems like these can distort reported profit and make it a poor guide for operating decisions. For example:

The export division manager in the first company above could increase his reported profit by any sale which yielded net proceeds in excess of standard manufacturing costs. Many such sales, however, cut into total company profit because of their effect on manufacturing costs.

This situation was complicated by the fact that the domestic division manager did not have authority to refuse goods to the export division. But even if he could have done so, the existing transfer price system would not have given him an appropriate guide for action. *Some* of the export sales undoubtedly would have been more than profitable enough to offset the resultant rise in manufacturing costs. But cost-based transfer prices would not necessarily reveal this information.

The transfer price mechanism should give the division manager the information he needs in order to make a rational choice. To meet this objective, several solutions have been proposed. Some center about *market prices* for intermediate goods, while others embody the principle of *marginal cost*. Space does not permit evaluation of these solutions here, but it seems clear that standard manufacturing cost or cost plus a fixed markup are inadequate to the task of providing relevant information for decision making.

Accounting problems are raised by market-based or marginal cost-based transfer prices, but they are by no means insurmountable. The objection is sometimes made that both these devices distort recorded inventory values—market-based prices because they *may* include a profit for Division *A* in the cost of Division *B*, marginal cost-based prices because they omit a portion of the fixed costs of Division *A* in figuring the costs of Division *B*.

Admittedly, this poses a special problem for the accountant—since intracompany profits or losses must be eliminated in published financial statements for the company as a whole. But this problem is not conceptually different from other consolidation problems, and therefore it should not act as a barrier to adoption of improved methods of transfer pricing.

TRANSFERS OF SERVICES

The second kind of transfer price problem arises in handling service center and central management costs. Two basic principles apply in this connection:

1. The profit center should not be charged at all unless some functional relationship can be determined between service center cost and the profit center's demand for service.

2. Above all, no after-the-fact distribution of *actual* service center costs should be made. Actual unit costs for service are related to the *total volume* of service provided and to the *efficiency* with which the service center is run.

Changes in these costs are not relevant to appraisal of the individual profit center manager. That is, the total amount charged to one division should not be dependent on the volume of service utilized by other divisions or on how efficiently the service center manager happens to control his own costs.

What *is* wanted is a measure of how the activities of individual profit centers affect the costs of central management and other service units. Only incremental or marginal cost can provide this information. In this connection, the meaning of "incremental costs" must be very carefully defined. It must be recognized that when volume is stepped up to a new capacity range, certain costs previously classed as "fixed" will rise. In these circumstances incremental cost must be understood to include these step-function increments as well as the narrower volume increments.

Take company administration expenses, for example. If a cause-and-effect relationship can be found between the demands of the division for central office administrative services and the cost of providing those services for the company as a whole, then the division should be expected to pay for any costs incurred on its account—that is, the variable costs of providing the services. This portion of administrative overhead should certainly be laid at the division manager's doorstep because his actions influence the level of such costs—and this effect should enter into his decisions.

Because the division manager cannot control the efficiency with which central office services are performed, he should be charged at some standard variable cost, based on attainably good performance. The fixed portion of central administrative expense and any deviations from budgeted or standard costs of administration should remain a general charge against over-all company profitability.

There would be no theoretical objection to using market-based transfer prices for transfers of services as well as of goods, but for many items this would not be feasible—e.g., the president's salary. For other items it would be administratively too complex. However, if the service center or

central office unit *can* chop up its services in such a way that the profit center manager can determine the cost to him of some market alternative (either buying the service outside, or staffing up to perform the services himself), then a market-based service charge is permissible.

One common method of handling joint facility costs is to charge the individual profit centers on the basis of some amount per unit of activity or per unit of service provided. Thus, general office costs might be assigned to divisions at a certain rate times total division payroll; maintenance expense might be charged at the average total maintenance department cost per hour of service time. Another frequently used method is to make no charge during the year but to distribute actual office and service department cost to divisions at year-end on the basis of burden distribution sheets.

But both these methods are arbitrary. They provide the profit center manager with information that may be misleading, particularly if he is led to regard fixed costs as variable or variable costs as fixed.

OPPORTUNITY COSTS

One other aspect of the transfer price problem remains. Certain elements of cost that appear to be fixed and noncontrollable at the profit center level may be at least partially controllable. Principal among these may be space costs, insurance, and interest on invested capital. In deciding whether to show any of these items as deductions from revenue on the division's income statement, two questions should be asked:

1. *Would some other control device be equally or more effective?* For example, a performance appraisal standard that relates profit to an investment base may be sufficient to stimulate the profit center manager to reduce his working capital requirements and eliminate idle and obsolete equipment, thus reducing his investment base and increasing his profit ratio.

2. *Will charging the cost stimulate profit center managers to reduce it?* For example, if space could be rented on the open market, it might be desirable to charge the profit centers for space on the basis of its rental value rather than on an average cost basis. One company which adopted this procedure achieved the startling response of a one-third reduction in office space utilized within a period of six months. The rental income from the space thus freed added several cents to the per-share earnings of the company's common stock.

This practice should not be carried so far as to destroy the meaning of the controllable profit figure. What is suggested is that any item which can be controlled by the division manager should be charged to him. The resultant controllable profit figure can then be compared with predetermined standards of performance for the level of activity achieved.

52. DECENTRALIZATION AND INTRACOMPANY PRICING

Joel Dean*

Joel Dean shows how decentralization can be made more effective through a new system of executive control which has the two intermeshed features of (a) profit centers and (b) competitive transfer prices.

Our industrial system today is made up of many large, multiple-product, multiple-process companies. As these companies have expanded, it has become generally recognized that the best pattern for their managerial organization is one of decentralization, i.e., the setting up of more or less autonomous operating divisions within a company. But as more and more large companies have adopted divisional management, they are finding that splitting up the enterprise and exhorting the divisional managers to go out and set new records for sales or production does not always accomplish the hoped-for profit results.

For an autonomous division to be an economically effective operation it has to follow the same basic rules of behavior as any independent firm competing with other independent firms, and this implies the same standards of economic performance—profits. But how can it be held to such competitive standards if there is no sound way to price the products transferred to it or from it in dealings with other divisions of the same company?

In the course of the discussion I shall set forth these propositions:

Transfer prices are necessary for almost all large companies. Trying to do without them sacrifices so much that it is no solution at all.

Intracompany price discrimination is not good business, either for the individual firm or for private enterprise in general.

There is need of a new system of transfer prices featuring: (a) profit centers with operational independence, access to sources and markets, separable costs and revenues, and profit intent; and (b) competitive pricing among these centers.

Such a system has many advantages. It brings the division manager's interests closer to those of top management, provides a more accurate basis for evaluating his performance, bulwarks his independence, and gives him sound guides in purchasing and marketing decisions.

Most present systems for setting transfer prices, by contrast, are inadequate. They employ economically indefensible methods, keep many losses hidden, and have a negative value in the making of management decisions.

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It takes time and patience to install competitive transfer prices. Top management will find it easier to make the change-over if it follows eight rules drawn from experience. Executives should also be prepared to meet certain objections which critics are likely to raise.

Here are the key terms which will be used in this article:

Transfers mean movement of product between operating units within the largest policy-making unit, regardless of corporate entities; for example, transfers within the family of companies represented by the Cities Service Oil Company or among the divisions of E. I. du Pont de Nemours & Company.

Product should be broadly interpreted to include raw materials, components, and intermediate products and services as well as finished porducts in the ordinary sense of the word.

Transfer price refers to the net value per unit that records the transaction for the purposes of operating statements.

NEED FOR SOUND PRICING

Why not dispose of the problem altogether by doing without transfer prices? For most large firms this solution sacrifices too much. Abolition of transfer prices prevents meaningful measurement of the profits of individual operating units, such as refineries, bulk stations, and service stations. It also prevents accurate estimates of the earnings on proposed capital projects. Basic decisions about market penetration, pricing, and capital expenditures are cut adrift from cost or profit moorings. And there is no way to assure that the product will be directed where it will produce the highest dollar return, either as among alternative processes or as among alternative channels and levels of distribution. The river of crude oil suddenly goes underground, disappearing from cost and profit sight, and comes up again at the consumers' doors, millions of processing dollars away.

So abolition is not the right answer. In fact, it is no solution at all. For most large companies the problem remains one of learning how to live with and use some system of internal transfer pricing. Sound transfer prices give division managers both the economic basis and the incentives for correct decisions. They also provide top management with profit and loss information indispensable for evaluation of the results of complex combinations of managerial skills and diverse facilities. Thus correct transfer prices are the basis for attaining the managerial decentralization sought by virtually every large American enterprise today.

One reason this has been such a problem for executives is that no systematic analysis of transfer pricing principles and policies has, so far as I can learn, heretofore been available.

NEW CONCEPT

How can the hodgepodge of intracompany pricing methods that is found in many large companies today be avoided? What is an economically realistic basis for intracompany pricing applied uniformly throughout the whole company? The answer lies in a new system of executive control which has the two intermeshed features of profit centers and competitive transfer prices.

PROFIT CENTERS

Before responsibility for profits or losses can be assigned, it is necessary that the management of the particular operation be in fact made primarily responsible for its economic performance. Four characteristics distinguish this type of autonomous unit from service functions:

1. *Operational independence*—Each profit center must be an independent operating unit, and its manager must have a large measure of control over most if not all operational decisions that affect his profits. This means that he must have considerable discretion in determining the volume of production, methods of operation, product mix, and so forth, subject only to broad policy discretion from top management. The areas of the company where this independence of action cannot exist should properly be considered as service centers. For them, the volume and character of services rendered are to a large extent determined by decisions originating outside their divisions; an example is the public relations department.

2. *Access to sources and markets*—The profit-center manager must have control over all decisions relating to sources and markets. He must be genuinely free to buy and sell in alternative markets both outside the company and inside. For example, the manager of the canned meat division of an integrated meat packer must know that it is just as respectable to buy uncured hams outside the company as to buy from the company's own pork division.

Freedom to trade is essential to the new concept because it dissolves alibis. Brother buyer and seller have ample incentive to reach agreement on prices if neither is restricted to a particular source or market. They have almost no incentive, and everybody feels cheated, if these channels are predetermined.

The required access to sources and markets cannot be created by edict; outside sources or markets must either be there or be capable of creation.

3. *Separable costs and revenues*—A profit center must be able to split off its costs and find an economically realistic price of the end products; otherwise measurement of its profit performance is impossible. This requirement eliminates service-type staff activities from consideration.

4. *Management intent*—A distinction between a profit center and a service center can also be drawn in terms of management's intention. Only if the basic goal is profits should the operation be treated as a profit center.

A service activity may contribute as much or more *in fact* to the company's profitability as an operating division, but still not qualify because top management does not and should not judge its performance solely on the basis of profitability.

In surveying operations within the company to determine which should be profit centers, management may want to restudy the fundamental objectives of each operation. The proclivity to view many activities as service center lean-tos for major divisions or the company as a whole should not lead top executives to ignore the advantages of conducting every possible operation as a profit center. Particular care should be taken in marginal cases.

To summarize, the modern integrated, multiple-product firm functions best if it is made into a sort of miniature of the competitive, free-enterprise economic system. The firm should be comprised of independent operating units that act like economic entities, free to trade outside the company as well as inside. Each such entity or profit center will, in seeking to maximize its own profits, do what will also maximize the profits of the entire company, just as individual firms in a private-enterprise society, by seeking their selfish advancement, generate the high productivity and well-being of a competitive economy.

COMPETITIVE PRICING

The underlying requisite for profit-center controls is competitive prices negotiated in arm's length bargaining by division managers who are free to go outside the company if unhappy with prices paid by or to brother division managers.

Small differences in the unit price of transferred products can make big differences in the division's profits and executive bonuses. Intracompany pricing must preserve the profit-making autonomy of the division manager so that his selfish interests will be identical with the interests of the company as a whole. This can be accomplished by following three simple principles:

1. Prices of all transfers in and out of a profit center should be determined by negotiation between buyers and sellers.

2. Negotiators should have access to full data on alternative sources and markets and to public and private information about market prices.

3. Buyers and sellers should be completely free to deal outside the company.

The practical benefits of sound transfer pricing for profit-center control are not always obvious. Many companies—especially if they are decentralized—seem to get along fine without it, never knowing what they are missing.

In a big company there is danger that interest in making profits will be diluted as a result of managerial specialization and the separation of operation from ownership. The parochial ambitions of operating managers need to be held in check; performance should be judged in terms of alibi-proof, objectively measured profits. When transfer prices are economically correct and profit centers are properly established, top management can delegate and still have peace of mind, because the division manager's targets and incentives will be so set up that his interests are identical to those of top management.

How to protect the independence of operating divisions against the insidious encroachment of staff advice, the restrictions of policy rules, and the fettering effect of top-level supervision is an ever present problem.

The harm that can be done by arbitrary and authoritative pricing of intracompany transfers is hidden. Such prices lead to sins of omission as well as sins of commission. They fail to give definitive indication of the profitability of added volume. They rob management of an economically correct basis for evaluating various profit figures. They provide a distorted and incorrect measure of the economic desirability of different channels of distribution. Bad transfer prices can also misdirect capital investment and cause friction and dissension among executives.

But negotiated competitive transfer prices can prevent these losses. They can make the division's procurement, processing, pricing, and distribution sensitive to market requirements and responsive to competitive alternatives. They provide sound guidance in making purchasing decisions, indicate the extent to which additional processing will be profitable, and direct the flow of products so as to make the greatest net profit for the company. Furthermore, the very process of negotiation avoids arbitrariness and tends to create agreement. This eliminates the cause of much friction and ill feeling.

OTHER PRICING SYSTEMS

What about existing systems of setting transfer prices? How adequate or inadequate are they? Various bases are now in use, such as:

Published market prices—Example: uncured hams priced to the canning division at prices reported in the *National Provisioner.*

Marginal cost—Example: electric motors transferred to the refrigerator division at cost of materials plus direct labor.

Full cost-plus—Example: gasoline transferred to the transportation division at the refineries' full costs plus a "fair" profit markup.

Sales-minus—Example: transfers of gasoline from the refinery at the retail price minus an allowance for the marketing department's services in getting it from the refinery to the customer.

Traditional prices—Example: the transfer price of financing service, a customary 6%.

The choice among the different transfer pricing systems depends both on the kinds of information that are available and on the objectives that the management hopes to accomplish through the system.

If no measurement of the competitive market price exists for the intermediate product, some type of cost basis may have to be used, unless a negotiated price can be based on indirect alternatives of buying and selling units. But choice among cost bases may be narrowed by the kind of cost records used.

In the event that available information does permit a free choice, then what management wishes to accomplish by intracompany pricing should determine the system to be followed. For example, if a company wishes to use intra-company pricing as the primary means for controlling costs and profits, for measuring operational results, and for directing the product flow in the most profitable ways, some sort of market price system is clearly indicated.

Now let us examine the relative advantages and disadvantages of the different systems used today for setting transfer prices, so that we can see how they compare with the competitive pricing method advocated here.

PUBLISHED MARKET PRICES

Basing intracompany transfers on published statistical reports of market price has much merit. It often approximates the ideal of a competitive transfer pricing system. But practical difficulties arise from three sources:

1. *Conditions may make published statistics an inaccurate statement of the market price for the size, quality, timing, and location of the intracompany transaction*—Market price statistics often have systematic time lags which make them an inaccurate picture of the true market at near turning points. Also, they may represent a different quantity, grade, type of package, or duration from the intracompany transaction.

2. *The market place may not offer a real alternative for the intracompany buyer or seller*—The volume traded on the market may be so small compared with intracompany transactions that an attempt to get supplies there would drive up the price. Or the quality standards of its market plan may be lower than those of the company or fail to meet the peculiarities of design and appeal of the company's own brand, so that price comparisons are futile.

3. *It may be difficult to distinguish between nominal price quotations and real ones*—No matter how honestly and carefully prices are reported, there are times when a very few strategically placed transactions can make a big difference in the published price. When these published prices affect the divisional manager's promotion and pay, he cannot be expected to be blind to opportunities to "make" the market. Cunning maneuvers of this sort are hardly in the company's interest.

MARGINAL COST

Next to negotiated transfer pricing, marginal-cost pricing is most defensible economically. Under this plan transfer prices are based on the additional cost caused by the production of an additional unit of the product. Moderately close approximation to marginal cost can be made by confining costs to those that vary with volume and are traceable—i.e., direct costs. This is the best of the authoritarian pricing schemes for these reasons:

1. It determines cost of underlying processes in terms that are relevant for short-run operating decisions on pricing, promotion, and product policy.
2. The buying division has a guide as to when it is in the company's interest to acquire a product or material from outside sources so long as it knows the short-run marginal cost of producing the product inside the company.
3. Troublesome and contentious problems of assigning overhead costs to joint product operations and changing overhead loadings as a result of variations in operating rates are avoided.

Marginal-cost pricing has, however, several distinct disadvantages:

1. Divisional profit and loss statements are made meaningless as a measure of economic performance. All contributions to profits are passed along to the final operation, and therefore no profits appear for earlier divisions. This gives the last division, frequently the sales division, a big cushion for maneuvering. No wonder sales divisions like marginal-cost transfer pricing!
2. Where many divisions handle products in succession, operating management may overlook profitable changes in methods or product flows because the inefficiencies of one division are covered up by the low costs of more efficient divisions that worked on the product in earlier stages.
3. Commercial abilities that are so desirable in a well-rounded division manager are stunted under marginal-cost transfer pricing. He is isolated from the pitfalls and opportunities of the market and is confined to the role of a service division manager.

FULL COST-PLUS

Cost-plus pricing sets intracompany prices on the basis of the complete costs of the producing unit plus some allowance for profit. Many variations of the system, both as to the cost base and the add-on, are possible.

The commonest cost base is orthodox accounting costs for the latest period. Normal cost and standard cost are sometimes used. The add-on or profit ranges from a niggardly coverage of overheads to a markup on sales which produces a handsome return on investment. The standard for the amount of profit takes two principal forms: (a) a margin on sales and (b) a rate of return on investment. In practice, partly because of the difficulty of determining profit margins on reasonably similar operations, the margin is usually set arbitrarily.

Bare costs with no add-on were more common in the past than now. They are frequently justified on moral grounds: that it is wrong to take profit out of the hide of a brother division. Today, full cost plus a "reasonable" rate of return on the investment of the selling division appears to be gaining wider acceptance.

Supporters of full cost-plus pricing of transfers claim these conflicting virtues of the system:

1. That the company is assured of an adequate profit on the entire process if transfer prices at each stage force the addition of a profit.
2. That no company can make money by selling things to itself and allowing divisions to exploit each other; therefore prices limited to costs plus a fair margin should be used to prevent conflict and promote cooperation.
3. That cost-plus pricing assures that the economic benefits of integration will be achieved and will be passed on to the company's customers.
4. That cost-plus pricing makes the producing and supplying units attend to the business of producing cheaply without being diverted by concern about commercial problems of pricing sharply.

None of these virtues, however, minimize the fact that cost-plus pricing is arbitrary and authoritarian. As such, it provides a poor basis for evaluating division performance, it beclouds profits, and it inevitably diverts production into uneconomic channels.

SALES-MINUS

Basing intracompany transfer prices on what the customers pay has considerable vogue, particularly in organizations which are strongly market-oriented. Transfer prices are geared to final selling prices by sub-

tracting allowances that more or less completely provide for the costs and profits of intervening operations.

This system has the virtue of being oriented toward the market value of the final product. However, it shifts the full impact of fluctuations in final price to that basic production units of an integrated firm, with the intermediate processing and marketing operations sheltered by an assured margin. In a buyer's market like that recently experienced in textiles, sales-minus pricing for gray goods would come close to what outside textile mills, hungry for business, could be forced to sell at. Under these supply and demand conditions, transfer prices that would approximate competitive market prices and realistically negotiated prices would result from sales-minus pricing. In a seller's market, by contrast, sales-minus pricing will undershoot the market; a division will not be able to get from intracompany transfers what it could get from outsiders or what it could negotiate at arm's length with brother divisions.

TRADITIONAL PRICES

A weird throwback to medieval times when the concept of "just" price prevailed is occasionally encountered in modern business. The use of traditional prices in transfer pricing belongs in this category. An example is the costing of financial services at 6% in intracompany charges; such a rate has borne no relationship to the market place within the memory of today's executives.

It is hard to see any advantages in this method, beyond the fact that it is as convenient and consistent as most of the concepts of feudalism. But the other methods now in vogue are not much more useful. All have serious shortcomings; none can be relied on to produce profit-oriented decisions by division managers.

INSTALLATION AND OPERATION

We turn now to the more mundane problems of what needs to be done to install and operate competitive transfer pricing.

COMPREHENSIVE STUDY

A practical starting point is a systematic, impartial study of the intracompany pricing methods the company is now using, and the facts that can be marshaled concerning market prices and market price relationships. The next thing to do is to lay the foundation of understanding of the economic and management philosophy, the benefits, and the problems of this new concept of competitively negotiated intracompany dealings.

Managers of profit centers and of service centers need a new orientation—one that is pointed toward the economics of their operation rather

than exclusively toward the technology of the operation. When they become managers of profit centers rather than merely managers of factories, they need a new set of ideas, values, and facts, with dimensions broad enough to embrace market-place choices and competitive return on capital expenditures. All this takes time as well as education. Overnight installation by a presidential decree of the new transfer-price and profit-center policy is not likely to succeed or last.

GRADUAL PROGRESS

After the research and educational foundation has been laid, a program of gradual installation can be tailored to the company's needs. The following rules should prove helpful:

1. *Widen the coverage gradually.* Start with areas where competitively negotiated pricing is easiest and take on the tougher ones as know-how improves.

2. *Apply first to basic volume.* Start with negotiated prices on the minimum basic quantities needed for planned future production. Negotiate term contracts for the distant future, so that both buyer and seller will have maximum fluidity and alternatives. Then gradually move toward arrangements for the fluctuating sector of volume for which real alternative outside sources get quite restricted. For these negotiations the trading experience and regard for long-term interests gained in previous dealings will help to steady the bargaining by curbing temptations toward exploitation in the short run.

3. *Establish pricing guides through research.* For products and components where the producing division has had no occasion to study market prices and outside trading opportunities, a foundation of knowledge must be laid so that neither brother division will be handicapped by ignorance in negotiating a competitive price.

4. *Set pricing limits temporarily.* These initial limits on the range of prices over which bargaining can take place will become as vestigial as the hip bone of a whale when the system gets into operation. But they provide assurance and prevent undue exploitation of ignorance at the outset.

5. *Limit the volume of outside trading initially.* The freedom to trade outside can be temporarily restricted by setting volume limits as, for instance, 75% inside the company, 25% outside the company. Those who fear that the advantages of integration will be dissipated are reassured by this expedient.

PRICE MEDIATOR

One executive is needed to (a) pull together the transfer-price and profit-center investigations, (b) organize the conferences and training

sessions, and (c) supervise the gradual installation of the new system of economic controls. To ease the transition, both emotionally and economically, this executive also can temporarily undertake to mediate the negotiation of some transfer prices.

Note that the price mediator should not attempt to arbitrate. The experience with price arbitration is almost universally bad. It is expensive and time-consuming, and the results do not satisfy either party. Everyone feels cheated, and everyone has an alibi for his profit and volume results. Instead the mediator should aim at securing agreement by keeping the negotiations going, by supplying information, and by exercising business judgment on issues of fact as well as on commercial alternatives.

One of the functions of the mediator, particularly in the early stages of installation, is to distill the truth from conflicting, misguided, exaggerated, and prejudiced pricing facts which the negotiating parties often bring to a mediation conference. To illustrate again:

> In negotiating transfer prices for a pharmaceutical firm, the participants faced two major common problems: (a) the outside market was very thin, with a wide spread resulting between highest and lowest prices at which sales were made; and (b) the transactions covered by this range differed from the intracompany transactions in volume, packaging, location, and so on. Quite naturally, each party came to the negotiations with a highly biased sample of market transactions to support its point of view. The triumph of the transfer-price mediator was to demonstrate to both parties that extreme prices, ranging from 50 cents a pound to $1.50 a pound, were inapplicable; he managed to narrow the range within which both parties agreed that the real market lay for the transactions in question.

As profit-center managers gain experience in using the competitive pricing system and grow to appreciate its value, the effective mediator will work himself out of a job.

TERM CONTRACTS

The period over which the transfer prices are to be negotiated should be at least as long as the planning period required to design and schedule production, or to dig up satisfactory alternative outside sources, whichever time period is longer.

In cases, *short* run negotiations concerning transfer prices have the hallmark of bilateral monopoly; they are similar to wage-rate negotiations. They generate heat, bad temper, and rarely produce economic transfer prices that are gauged and policed by outside alternatives and freedom to use them.

But over a long period even a branded product like an automobile can properly be subject to transfer prices that have the virtues and characteristics of a free-enterprise system. If long-term specifications contracts are negotiated, the buying unit will generally be able to get out-

siders to bid on products made to its requirements, and a producing unit will have a real choice—either to adapt its output to other uses or to again assume the commitments on design, volume, and productive facilities which are tied to the branded product.

GOOD BUSINESSMEN

Successful operation of a profit center under a miniature free-enterprise system within the corporate fold calls for talents and experience often summed up by the tag, "He is a good businessman."

These abilities need to be systematically cultivated because they are not likely to have survived in a big corporate bureaucracy where transfer prices have been authoritarian. Executives of highly centralized companies are likely to have been reared as if they were in one big happy family, in which each child has an assigned set of chores and emphasis is on cooperation and the subordination of individual desires to group interests.

ANSWERING OBJECTIONS

Any new system of transfer prices will be criticized, and this one particularly because it removes needed alibis and may blemish careers by exposing executives' inadequacies. In addition, it may appear to be fundamentally opposed to the reason for existence of a large multi-product corporation. Therefore anyone who is considering this new system of intracompany pricing and profit control needs to give some thought to the objections that are likely to be viewed as most telling by those who doubt.

CONCLUSION

Difficulties of installation and operation *can* be overcome; questions of criticism and skepticism *can* be met. Management will do well to make the necessary effort in view of the deficiencies of existing transfer pricing systems:

1. Economically indefensible methods of intracompany pricing are widely used in American industry.

2. Losses sustained from bad transfer prices do not show up on any set of books, because what would have happened under economically correct transfer prices will never be known. Anyone who has tried to restate in terms of correct transfer prices what has been reported in terms of wrong ones will testify to the practical impossibility of measuring the

foregone profits. In other words, whatever losses result from noneconomic transfer prices are well and forever hidden.

3. Bad transfer prices do not necessarily lead to losses; but if they do not, it is because no attention is paid to them in making decisions. In some companies the critical decisions concerning flow of product, degree of processing, and channels and geography of distribution can be made without reference to any internal costs or prices. In such companies bad transfer prices may do no harm—they also do no good. And if the operations of these companies do not require an economically correct system of transfer prices, they probably require no intracompany pricing at all.

As a practical matter the chances are strong that an unsound system of transfer pricing *will* cause harm. For a large integrated organization with a diversified product line which is sold to a variety of industrial, commercial, and consumer market levels, the only system which will accomplish the needs of management is one based on negotiated competitive prices.

XIV

PLANNING AND BUDGETING

53. PRACTICAL APPLICATIONS OF COST-VOLUME-PROFIT ANALYSIS

James D. Willson*

"Profit planning" is discussed by a leading author of the subject. The article is an excellent summary of the probable effect of various proposals on costs (variable and fixed), price and volume, and the resulting impact on profit. The interrelationship of the items is demonstrated by means of equations and graphs.

The success of a top business executive today depends in large part on his ability to deal effectively with probable conditions of tomorrow. In such a task he needs knowledge of the economic characteristics or structure of the business he manages, which the accountant can provide him. The principal accounting official should constantly make available to the chief executive such information, in readily understandable reports, to enable him to evaluate the hazards and recognize the potentials in the various business alternatives available.

This entire field of "profit planning" has become associated with the break-even analysis, or the cost-volume-profit inter-relationship. We will not concern ourselves here with the usual preparation of such planning or

* From *National Association of Accountants Bulletin,* XLI, 7 (1960), 5-18. Reprinted by permission of the National Association of Accountants.

control devices as variable budgets or forecasts. It is assumed that the reader has a reasonable knowledge of the principles related to these areas of planning and control. Our starting point is in a more sophisticated area —the application of the break-even analysis and related data in profit planning techniques. Let us consider the forecast, for instance. What purpose does it serve? Is it satisfactory? How do we know? If your company is typical, there are many useful ways of putting cost-volume-profit analysis to work. Such a technique is not merely a means of determining at what point income equals outgo and the business "breaks even." The dynamic company of today wants more than to just break even. Profits or the expectation of profits must be in the picture, or the incentive under the free enterprise system is gone.

The significance of this type of thinking may be illustrated by some of the questions which management is prone to ask and which accounting executives should be ready to answer, or assist in development of the answer, by the use of break-even analysis:

1. Does the forecast represent a reasonable profit objective? More particularly for this purpose, are costs and expenses in proper relationship to income?
2. What will be the operating profit or loss at X sales volume?
3. What profit will result from a fifteen percent increase in sales volume?
4. What additional sales volume is necessary to produce X dollars of operating profit?
5. What additional sales volume is necessary to offset a ten percent reduction in selling price?
6. If the company can reduce fixed costs by X dollars and achieve a five percent reduction in material costs, what will be the effect on income?
7. What is the required sales volume to meet the additional fixed charges from the proposed plant expansion?
8. What sales volume is needed to provide for all costs in Territory Y?

Can you give an intelligent answer to intelligent questions of this nature as applied to your company? If you cannot, take heart. The techniques to develop answers to these questions are essentially quite simple.

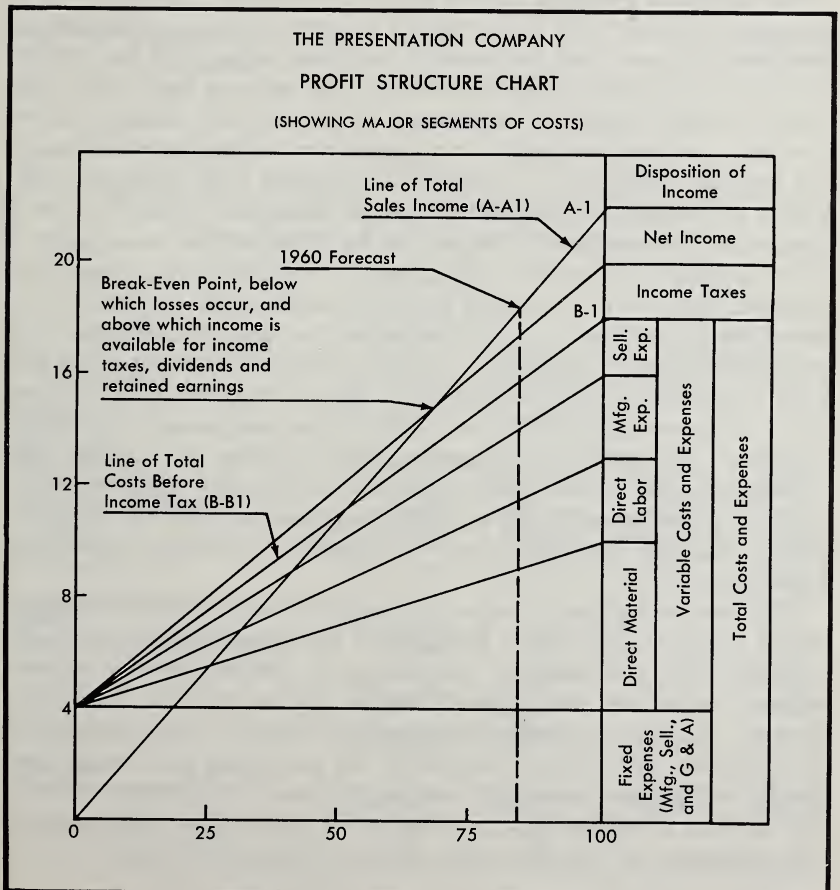
BASIC ASSUMPTIONS IN COST-VOLUME-PROFIT ANALYSIS

Before discussing some adaptations of the cost-volume-profit analysis to planning and control, a review of a few simple fundamentals might be helpful. The effectiveness of our application depends in large part on proper assumptions relating to costs and profits. The economic structure of a company may be portrayed in the more simple break-even chart to depict merely the profit or loss effect of an increase in volume of sales as related to a ratable increase in variable costs, with a sales income line, a

fixed cost line, and a line of variable costs. It may also be portrayed in a more refined but complex presentation, as in EXHIBIT I, setting forth the relationships to sales volume of various costs and expenses. Regardless of the degree of complexity of the analysis, the principal assumptions on which such a study is based are:

1. Unit selling prices will not change with volume.
2. Costs and expenses can be segregated with reasonable accuracy into their fixed and variable components.
3. Fixed or standby costs will remain constant in the aggregate within the limits of the study.
4. Variable costs will vary generally in a constant ratio, i.e. in direct proportion to volume.
5. Where several products are involved, the mix will remain constant.

EXHIBIT I



When the proper cost segregations are known, income, costs, and the break-even point may be determined, with or without a chart. Whether or not it is decided to use the formalized chart in the determinations, the mathematical equation is:

$$\text{Break-even point} = \frac{\text{Aggregate fixed expense}}{1 - \dfrac{\text{Variable costs}}{\text{Sales}}}$$

The denominator, which is equal to the ratio of variable income to sales (marginal income ratio), represents that share of the sales dollar which is available to contribute to fixed costs and, if adequate, to income. It is a highly significant ratio. In analyzing economic behavior, this relationship becomes a much more useful concept than the break-even point itself.

USING BREAK-EVEN ANALYSIS TO TEST THE FORECAST

For illustrative purposes, we will consider the Sample Company with an economic structure such as that shown in EXHIBIT 2. It is to be observed that not only have fixed and variable costs been segregated but also the variable costs for each major function or cost segment have been translated into their applicable percentages of the net sales dollar. This information can now be applied in an evaluation of the reasonableness of the forecast. Typically, a projection is compared with some past year, usually the immediately preceding year, to determine whether or not it appears satisfactory. Such a comparison has value. It may be a gauge as to the adequacy of the sales volume and, in a general way, it may raise questions about cost or expense levels. However, such a comparison is not as sharp a tool as is available. Most of the time, the sales level and product mix in the forecast year will not be identical with that of the past year. Therefore, it may be difficult to measure more precisely the propriety of the costs and expenses in relationship to sales volume. To further complicate the problem, management, when looking at a higher sales volume and a net income which appears more favorable, tends to be less critical. In most instances, if net income expressed as a percent of sales is greater than the preceding year, the forecast is gleefully pronounced satisfactory.

Why not use a superior tool which permits a more effective evaluation of the volume factor? Once management has agreed upon a reasonable sales objective, a volume for the year under forecast, then it becomes practical to measure the proposed forecast against the break-even structure, i.e., to apply the break-even economic structure of the company to the projected sales volume. Essentially, we are saying that management should decide upon reasonable cost-profit-volume relationships and that this standard should be used as a measure of the forecast. The results of the application of the break-even factors, as shown in EXHIBIT 2, to a

EXHIBIT 2

THE SAMPLE COMPANY
PROFIT STRUCTURE

Description	Fixed Costs	Variable Costs Total	Variable Costs % Net Sales	Combined
Net Sales				$10,000,000
Costs and expenses:				
Direct material	$	$4,000,000	40.00%	
Direct labor		1,000,000	10.00	
Manufacturing expenses	500,000	1,000,000	10.00	
Selling expenses	400,000	100,000	1.00	
Research and development expenses	250,000	50,000	.50	
General and administrative expenses	150,000	50,000	.50	
	$1,300,000	$6,200,000	62.00%	7,500,000
Profit before income taxes				$ 2,500,000

EXHIBIT 3

THE SAMPLE COMPANY
BREAK-EVEN ANALYSIS OF FORECAST

Description	Fiscal 1960 Application of Standard Profit Structure	Tentative Forecast	Forecast Over (Under) Standard Amount	Forecast Over (Under) Standard %
Net sales	$12,500,000	$12,500,000	$	
Cost of sales:				
Direct material	$ 5,000,000	$ 5,250,000	$250,000	5.00%
Direct labor	1,250,000	1,310,000	60,000	4.80
Manufacturing expenses	1,750,000	1,820,000	70,000	4.00
Total	$ 8,000,000	$ 8,380,000	$380,000	4.75%
Gross margin	$ 4,500,000	$ 4,120,000	($380,000)	(8.44%)
Operating expenses:				
Selling	$ 525,000	$ 540,000	$ 15,000	2.86%
Research and development	312,500	310,000	(2,500)	(.80)
General and administrative	212,500	190,000	(22,500)	(10.59)
Total	$ 1,050,000	$ 1,040,000	($ 10,000)	(.95%)
Profit before taxes	$ 3,450,000	$ 3,080,000	$370,000	(10.72%)
Other data:				
Break-even point	$ 3,421,050	$ 3,714,290	$293,240	8.6%
Marginal income ratio	.38	.35		

projected sales volume (standard profit structure) and the comparison of such results with the aggregate costs and expenses as set forth in an illustrative forecast, are shown in EXHIBIT 3. It is to be noted that percentage relationships are developed to aid in detecting out-of-line conditions. The exhibit portrays one of the basic considerations in the preparation of forecasts, i.e., that the company must not be allowed to develop or assume a less favorable cost structure. Hence, it is necessary to apply some over-all tests quite distinct, for example, from individual departmental budget performance.

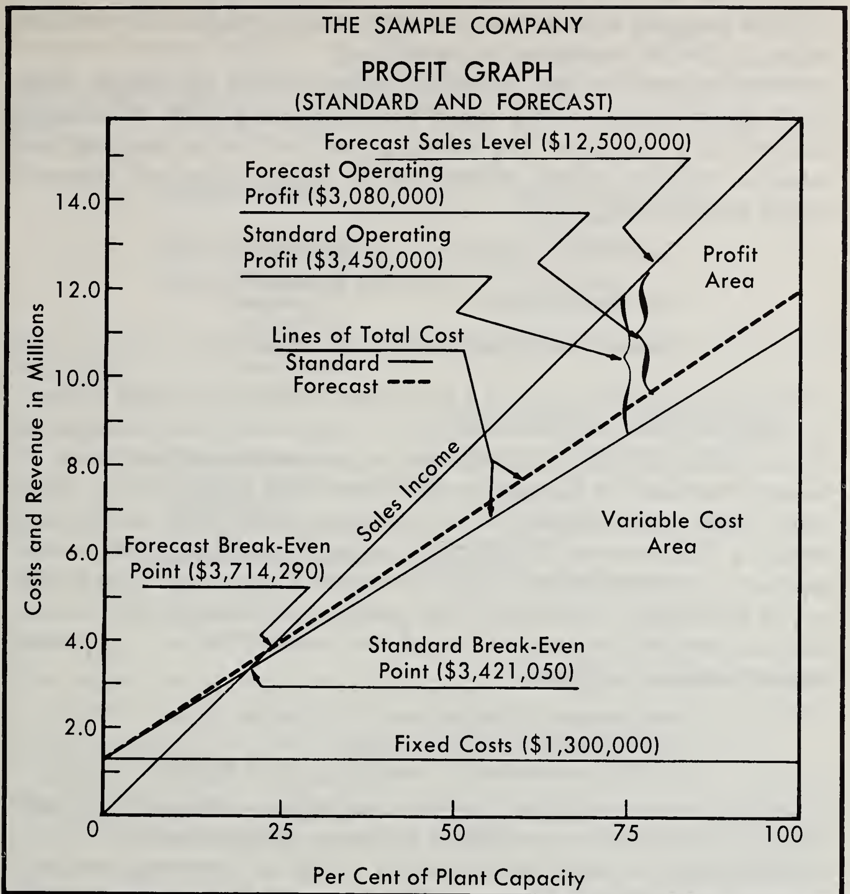
The greatest dollar increase and relative increase is in prime material costs. This 5 percent or $250,000 increase must be analyzed to determine whether the cost increase results from changes in product mix or from cost increases in any given product line. The initial break-even application has isolated this apparently excessive cost relationship. Now it should be analyzed in more depth and a decision made as to an acceptable plan. Perhaps the product mix is not the optimum believed to be attainable in the forecast year. Perhaps action can be taken on cost increases to reduce or eliminate them. The next largest relative increase, amounting to $60,000, is in direct labor. A similar analysis should be made to localize the cause and seek an improvement in the plan.

Next, manufacturing expenses have increased by 4 percent or $70,000. Departmental budgets should be reviewed to determine the areas of greater increase and causes should be determined. Management must then decide what corrective action need be taken. If, for example, the increase is in maintenance expense, is it sound to defer projects? What is the best approach when considering the longer term interests of the business? Similar analyses should be made of the other expense areas. If expenses are under the standard, the accountant should ascertain that no omissions have been made erroneously.

It is to be observed that the break-even point has risen by 8.6 percent to $3,714,290. Perhaps a better way to state the case is that the forecast is based on a somewhat changed cost structure. This change may be shown graphically as in EXHIBIT 4. The solid lines indicate the acceptable cost-volume-profit structure and the dotted lines reveal the condition as planned in the forecast. Incidentally, any change in these relationships can be readily shown on the graph, whether they appear in sales, variable costs or fixed expense.

In poor economic weather, a reasonable margin of safety is necessary. Accordingly, in the Sample Company, if management agrees that the standard profit structure must be maintained, every element should be analyzed and explored by the accountant so that the final business plan for the ensuing year retains the characteristics of this structure. As an alternative, once the most satisfactory cost-volume-profit relationship is determined, including the proper product mix, then the possibility of

EXHIBIT 4



securing additional sales volume to offset cost increases is to be considered.

OTHER USES OF COST-VOLUME-PROFIT DATA

A knowledge of the economic structure of the business, together with the related analysis, can identify areas of cost increases and, as illustrated, permit an evaluation of the forecast. In addition, such information can provide answers to other typical questions. The value of the cost-volume-profit concept is inherently in the facility with which volume can be treated as a variable factor. Because of considerations relating to the market or to expansion, management many times desires information concerning the results of a contemplated action, such as what the operating

profit would be at X dollars sales volume or what the effect on operating profit would be if X percentage increase in sales volume were realized, etc. The marginal income ratio and the related segregation of fixed expense simplify the solution of such problems.

Operating profit at any given sales volume—Using the Sample Company's profit structure, what would be the operating profit at an annual sales level of \$13,000,000? The operating profit will be the marginal contribution (amount of sales income less all variable costs and expenses) less the fixed expense:

Contribution margin	=	\$13,000,000 × .38
	=	\$ 4,940,000
Less fixed expense		1,300,000
Equals operating profit of		\$ 3,640,000

Effect on operating profit of a given percent increase in sales volume—In setting the sales objective each year or for several years, management typically likes to know the profit result at any number of sales levels expressed as amounts or percentages of increase. The answer may be determined easily from a reading of a cost-volume-profit graph as shown in EXHIBIT 4. This increased flexibility is a tremendous advantage of the chart approach. However, results from each requested percentage increase also can be individually calculated. If the present sales volume is \$10,500,000, with our marginal income ratio of .38, the computation of a 15 percent increase in sales is as follows:

Sales increase = \$10,500,000 × 15% = \$1,575,000
At marginal income ratio of .38
Produces an increase in operating profit of \$598,500

In such an instance, with no change in fixed expense, the operating profit is simply the sales increase multiplied by the marginal income ratio.

Sales volume required to produce X dollars of operating profit—In planning, management quite often decides that, for financial or other considerations, a given profit must be attained. The question then will naturally arise as to the sales volume necessary to produce it. In a calculation of this type, the desired operating profit becomes, in effect, the equivalent of fixed expense. If the desired operating profit of the Sample Company is \$4,200,000, then the simple computation and result are as follows:

$$\text{Required sales volume} = \frac{\text{Fixed expense} + \text{Desired operating profit}}{\text{Marginal income ratio}}$$
$$= \frac{\$\ 1{,}300{,}000 + \$4{,}200{,}000}{.38}$$
$$= \$14{,}473{,}700$$

Additional sales volume needed to offset a reduction in selling price—The sales department may insist that the present low sales volume is due

to prices which are out of line with competition. It may advise a reduction of 10 percent in these prices. We will assume that the company has a sales volume of \$10,500,000, with fixed expenses of \$1,300,000, and a marginal income ratio of .38. With a 10 percent reduction in selling prices, what sales volume is needed just to maintain present operating results? Our initial step is to calculate the present operating income as follows:

Marginal income	\$10,500,000 × .38
	\$ 3,990,000
Deduct fixed expense	1,300,000
Present operating income	\$ 2,690,000

Next, we must adjust to the changed marginal income ratio (or the variable cost ratio).

$$\text{Sales volume to offset reduced selling price} = \frac{\text{Desired profit} + \text{Fixed expense}}{1 - \left(\dfrac{\text{Present variable cost ratio}}{1 - \text{Proposed \% reduction in selling price}}\right)}$$

$$= \frac{\$2{,}690{,}000 + \$1{,}300{,}000}{1 - \left(\dfrac{.62}{1 - .10}\right)} = \frac{\$3{,}990{,}000}{.3112} = \$12{,}821{,}000$$

The required sales volume of \$12,821,000 represents an increase of about 22 percent over the present level. The ability to secure such an increase should be explored in terms of both sales potential and plant capacity.

Effect of changes in fixed expense and variable cost ratios—Since the objective of business management should be the earning of the maximum return on invested capital, consistent with proper social objectives, there is often a continuous search for reduced costs. In the case of the Sample Company, assume that management, after some study, feels the "normal" or standard profit structure may be improved. As an example, it may be concluded that direct material costs may be reduced 10 percent through certain substitutions and that fixed expenses may be lowered by \$250,000 annually. Then the question may be asked, "What would the probable operating profit be at a sales level of \$12,000,000 annually?" The answer could be calculated using the profit-structure shown in Exhibit 2:

The new variable cost ratio = Present variable cost of material less 10% plus other variable costs
= (.40 less 10%) + .22 = .58

The new marginal income ratio = 1 − variable cost ratio = 1 − .58 = .42

Now operating results may be quickly determined as follows:

Marginal income = Sales volume × marginal income ratio
\$12,000,000 × .42 = \$5,040,000

The $5,040,000 marginal income less the revised fixed expense of $1,050,000 ($1,300,000 − $250,000) will produce a more favorable operating income of $3,990,000. If preferred, a more detailed comparison of the present operation and the $12,000,000 sales level may be made as follows:

	Present		*Higher level*	
Description	*Amount*	*% Net Sales*	*Amount*	*% Net Sales*
Net sales	$10,000,000	100.00	$12,000,000	100.00
Variable costs	6,200,000	62.00	6,960,000	58.00
Marginal income	$ 3,800,000	38.00	$ 5,040,000	42.00
Fixed expense	1,300,000	13.00	1,050,000	8.75
Operating income	$ 2,500,000	25.00	$ 3,990,000	33.25

Advisability of plant expansion—Sooner or later most progressive businesses are faced with a problem of plant expansion. This solution should not rest merely on available funds. Rather, management should have a full realization of the economic questions involved and here, again, cost-volume-profit analysis can be helpful. The chief executive might find break-even analysis valuable in providing information needed in a critical review of the proposed commitment answering such points as:

1. Relative break-even points.
2. Sales volume required to earn the present level of profits.
3. Sales volume necessary to earn the same rate of profit on the proposed facility as on the existing one.
4. Maximum profit potential.

The development of these criteria is simply the application of the basic formula already discussed. There are simply more aspects to the problem and perhaps more sales attainment levels to consider before making an intelligent commitment of long-term funds.

Planning for adequate facilities preferably should take place sufficiently ahead of the date when the plant and equipment are needed for operations. In our example, the Sample Company, the sales forecast is already at the $12,500,000 level. However, management is of the opinion that the full plant capacity of $15,000,000 will be required within the next eighteen months. Therefore, assume these facts, using the profit structure (EXHIBIT 2) of the company.

Maximum annual earnings of the company with present facilities:

Net sales	$15,000,000
Costs and expenses:	
Variable (62% of net sales)	9,300,000
Fixed	1,300,000
Total	$10,600,000

Income before taxes	$ 4,400,000
Federal income taxes (50%)	2,200,000
Net income	$ 2,200,000
Annual fixed expense of new plant	$ 700,000
Desired annual income (net) on new investment	$ 140,000
Maximum sales volume of new plant	$ 8,600,000

On the basis of this information, these determinations can be made:

BREAK-EVEN POINTS

$$\text{Present facilities} = \frac{\text{Fixed costs}}{\text{Marginal income ratio}} = \frac{\$1{,}300{,}000}{.38}$$

$$= \$3{,}421{,}050 \text{ sales volume.}$$

$$\text{Proposed facilities} = \frac{\text{Present + Additional fixed expense}}{\text{Marginal income ratio}}$$

$$= \frac{\$1{,}300{,}000 + \$700{,}000}{.38} = \$5{,}263{,}200 \text{ sales volume.}$$

SALES VOLUME REQUIRED

To earn existing income =

$$\frac{\text{Present fixed expense + Additional fixed expense + Existing income}}{\text{Marginal income ratio}}$$

$$= \frac{\$1{,}300{,}000 + \$700{,}000 + \$3{,}450{,}000}{.38} = \$14{,}340{,}000 \text{ sales volume.}$$

To earn a given return on investment =

$$\frac{\text{Present fixed expense + Added fixed expense + Present return on investment + Return (before taxes) on new investment}}{\text{Marginal income ratio}}$$

$$= \frac{\$1{,}300{,}000 + \$700{,}000 + \$3{,}450{,}000 + \$280{,}000}{.38} = \frac{\$5{,}730{,}000}{.38}$$

$$= \$15{,}000{,}000 \text{ sales volume.}$$

MINIMUM EARNINGS POTENTIAL WITH NEW PLANT

Net sales (capacity)		$23,600,000
Costs and expenses		
Variable (62% of net sales)	$14,632,000	
Fixed or continuing expenses	$ 2,000,000	$16,632,000
Profit before income taxes		$ 6,968,000
Federal income tax (50%)		3,484,000
Net income—potential		$ 3,484,000

These determinations may be summarized for management somewhat in this fashion:

Description	*Present facilities*	*Prospective facilities*	*Increase*
Annual break-even sales volume	$ 3,421,050	$ 5,263,200	$1,842,150
Annual sales volume to earn existing income	12,500,000	14,340,000	1,840,000
Annual sales volume to earn desired return on new facility	12,500,000	15,100,000	2,600,000
Maximum sales volume	15,000,000	23,600,000	8,600,000
Maximum profit potential	2,200,000	3,484,000	1,284,000

A prudent management will consider carefully its ability to secure and maintain, at the assumed prices, an additional sales volume of at least $2,600,000. Moreover, because of a very favorable marginal income ratio and the consequent relatively small increase in sales needed to provide an adequate return, further thought should be given to:

1. Possible or probable competitive action and the need for price changes to discourage competition.
2. The prospects of achieving a more substantial increase in sales to utilize the new facilities and realize more of the profit potential.

USES OF COST-VOLUME-PROFIT ANALYSIS FOR PART OF THE BUSINESS

Previous illustrations have dealt with the use of cost-volume-profit analysis for the business as a whole. Yet, the same approach may be applied to problems relative to individual product lines, territories, methods of sale, channels of distribution, or any particular segment of the business which is under scrutiny. In all of these decisions, the significant factors are the marginal income ratio and the fixed expense or cost. Where both direct and allocated costs are involved, several different break-even points may be determined. For example suppose these conditions exist in a sales territory:

Direct and continuing territory selling expense	$310,000
Marginal income ratio	.25
Allocable share of home office (fixed) expense	$130,000

The sales volume required merely to cover the direct territorial fixed expense would be:

$$\frac{\text{Direct fixed expenses}}{\text{Marginal income ratio}} = \frac{\$310{,}000}{.25} = \$1{,}240{,}000 \text{ sales volume}$$

The annual sales volume sufficient to cover the direct expenses and allocated home office fixed expense would be:

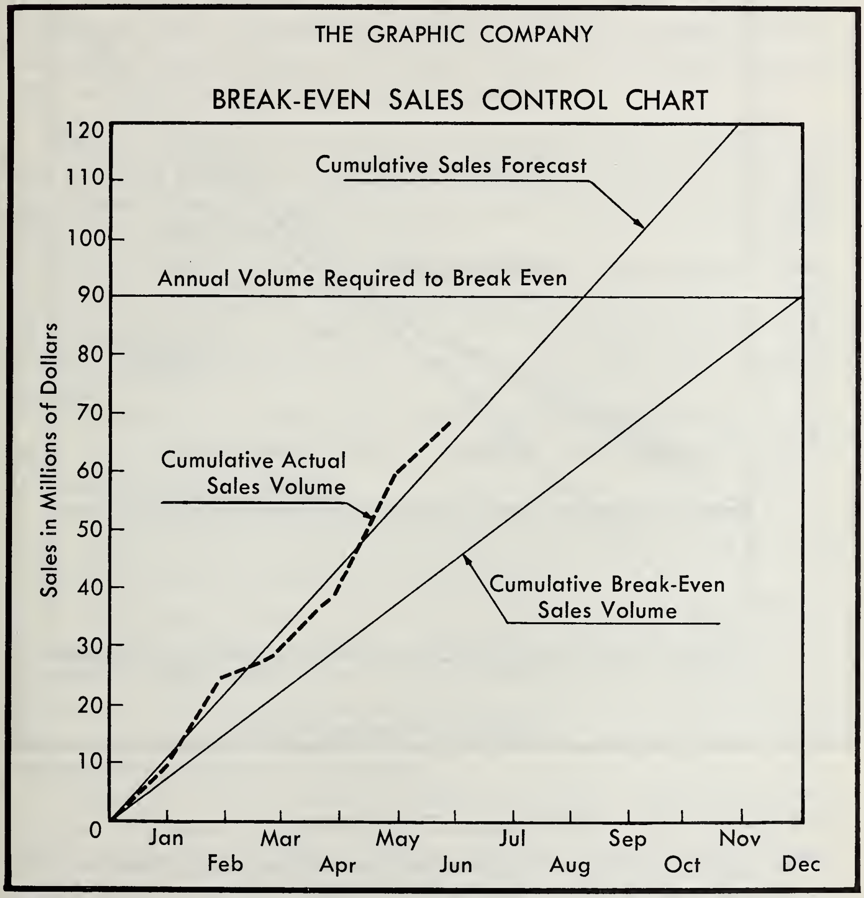
$$\frac{\text{Direct expense} + \text{allocated expense}}{\text{Marginal income ratio}} = \frac{\$310{,}000 + \$130{,}000}{.25} = \begin{array}{c}\$1{,}760{,}000\\ \text{sales volume}\end{array}$$

. . . AND IN CONTROL

The preceding discussion has related principally to the planning phase of business, that is, to showing what must be done to achieve a given objective. Once the best plan has been selected and the goal has thus been defined, the same cost-volume-profit analysis can be used for control purposes. Charts may be helpful in such an approach. One such application is a sales control chart as shown in EXHIBIT 5. This chart shows three important factors cumulatively: actual sales volume, sales forecast, and

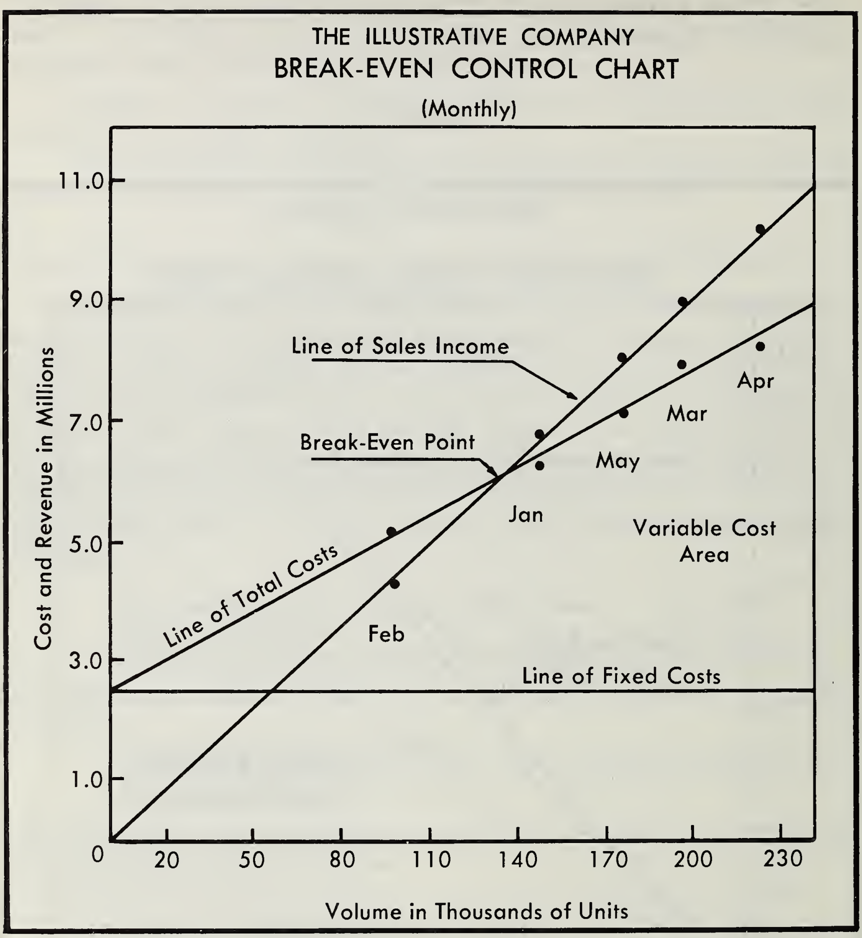
sales volume required to break-even. Based on existing sales plans, the chart shows that eight months of sales are required just to meet all costs and expenses and that profits will be realized for the year only after the cumulative sales level has been attained.

EXHIBIT 5



Another chart designed to show progress—or lack of progress—in keeping with the acceptable cost-volume-profit structure is illustrated in EXHIBIT 6. In this application, monthly costs are charted against the corresponding sales level to detect out-of-line trends.

EXHIBIT 6



A MAJOR HELP IN ANSWERING MANY QUESTIONS

The applications of the cost-volume-profit relationship, illustrated in this article, are suggestive only. Further refinements and modifications may be found necessary, desirable, and useful in your particular business. Moreover, as conditions change, the desired profit structure must be adjusted. Nevertheless, there are a great many questions that the cost-volume-profit relationship may help to answer. It is one facet of putting facts and figures to work for management and it is one of the more interesting aspects of accounting planning and control.

54. DYNAMIC BUDGETING—GETTING THE MOST FROM YOUR PROGRAM

James D. Willson*

The author lists several factors which have prevented the use of budgets from attaining popularity. Remedies are suggested such as "preventive budgeting" where current balances between budget and actual are maintained for important items. The author stresses the variable budgeting approach as well as the need to "sell" the budget.

Budgets and budgeteers are likely to be unpopular with executives down the line. The department head tends to resent his budget; he may even spend more time and energy thinking up good reasons for exceeding it than he does trying to keep within it.

Nor are budgets always an accurate guide for top management decisions. They can, and often do, arouse dangerous complacency by making it appear that costs are under close control when they are actually rising unduly. Figures cannot lie; but in the form of a budget they can easily mislead.

The fault, however, does not lie with budgets per se, but with the way they are compiled and used. Here, for example, are common symptoms of the wrong kind of budgeting:

1. *Information on budget performance comes too late to do much good.* You don't get figures on June performance until the 25th of July—fully 55 days after some of the costs were incurred.

2. *No account is taken of the level of activity*—and the extent of your cost control is misrepresented in consequence. Let's say your company planned to manufacture 15,000 air conditioners, and the budgets were drawn up on this basis. But actually only 12,000 were produced. Particularly in the expense area, a budget for a level of 15,000 does not fairly measure performance at a 12,000 level.

3. *Changes in plans make the budget inoperative.* Quite aside from volume of production the activities that occur may differ widely from those budgeted for. A change in the product mix or the method of manufacture, for instance, can make the budget quite meaningless.

4. *The company budgetary planning doesn't cover all activity.* Sales may be budgeted but not expenses. Manufacturing expenses may be budgeted while selling expenses are left largely alone.

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* From *Dun's Review and Modern Industry,* LXIX, 8 (1957), 62, 128-32. Copyright by *Dun & Bradstreet Publications Corporation.* Reprinted by permission of the publisher.

5. *Department heads and supervisors find the budgets difficult to work with.* Sometimes the budget reports are too detailed, and are presented in a form confusing to anyone but an accountant. Or the budget reports don't show the expenses the department head or supervisor can control. Or they don't tell him *where* he is over the budget.

PREVENTIVE BUDGETING

A partial answer to two of the difficulties (Nos. 1 and 5) lies in preventive budgeting, a method that makes it harder for the responsible executive to exceed the budget without doing so deliberately, and automatically centers his attention on the expenses over which he has control.

How is this done? Simply by accumulating costs of requisitions, *before* they are put through, and deducting them from the balance left after continuing expenses are provided for. Here are the suggested steps:

1. The budget director, or one of his staff, determines the allowable budget for departmental expense for the accounting period—usually one month.
2. The current level of continuing expenses—such as payroll—is determined.
3. The continuing expenses are deducted from the total budget—leaving the amount that the department head is more or less free to spend as he sees fit.
4. All requisitions are processed through a control point, often in the budget department, and deducted from the available budget. When a requisition that would send expenses over budget appears, the department head is immediately informed. He may then consider whether the purchase can be eliminated or postponed.

The essence of the whole procedure is the passing of commitment slips through a control point. No complex or specially printed forms are necessary; and if your budget staff is on its toes, there need be no significant delay.

Nor is it necessary to apply this control to *all* accounts of all departments, though that may be done. At first, the procedure might be used for critical accounts in critical departments—especially the areas where expenses have been too high or where dollar costs bulk large. In The O. A. Sutton Corporation, we apply the preventive budgetary control to these accounts, which represent the bulk of our indirect expenses: supervisory salaries, indirect labor, operating supplies, perishable tools, maintenance expense. Capital expenses are checked off against the capital budget or appropriation.

There are occasions, of course, when expenditures must be made even if they send a department over its budget. But these cases are rare and usually cannot occur without special approval from a higher echelon.

When the vice president for manufacturing must approve a requisition, the foreman will ordinarily avoid sending it in if he can.

This, however, does not completely solve the problem of making information available before it is too late to do anything about it, since the "commitments" subtracted from the budget to calculate the available balance will also vary. In most small and medium-sized companies, budget performance on total expenses is reported only once a month, which is generally not adequate for proper control.

A simple plan to provide more frequent expense information to all the department managers could make provision for these three steps:

1. Provision of cumulative month-to-date expenses, by account, by department, each week.

2. Provision of the detail of actual charges supporting each account total.

3. Computation of the *total* department budget to date (not by account) as a guide to over-all condition.

The ultimate, of course, would be computation (electronic) of budget and actual by account.

To achieve the weekly expense control on a practical basis, certain procedures have been found necessary:

1. Paper work should be processed continually, much as a production line flows. For example, invoices can't be held in the accounts payable department until near month end. Nor should expense requisitions be held in the cost department. This we might call "flow accounting."

2. Estimates may be used on occasion. Thus, if payrolls are written only every two weeks, then every alternate week may contain estimated expenses (based on a head count). These estimates are removed in the following week.

3. Fixed expenses, such as depreciation, may be included in the first weekly expense summary in total for the month, with a corresponding adjustment of the budget base.

Generally, good common sense should dictate the methods and the short-cuts that may be taken. All we need to do is apply a little imagination.

FLEXIBLE BUDGETS

It is accepted practice in the direct labor field to compare actual and standard hours for the production level. Also, actual direct material used is compared with standard at the production level attained. But for some strange reason, many companies measure actual expenses against a predetermined figure that takes no account of the level of activity. Thus an expense budget may be calculated at an assumed level of 22,000 man-hours, and actual experience for the month may be 15,000 hours. This

example indicates how meaningless the budget becomes in consequence. Or there may be Saturday overtime, and the foreman, who is supposedly responsible for the budget, may have no control of it; yet no adjustment in the budget is made in consequence.

As for changes in product mix, these can be provided for by converting planned production to a common denominator—standard labor hours, for example, pounds of product, or machine hours. Whatever the unit of measure, it should be expressive of all products and be the primary factor in expense levels.

By and large, all costs are subject to some degree of control. Therefore, why stop with, let us say, manufacturing expenses? Engineering expenses, research and development expenses, distribution costs, general and administrative expenses—all these are proper areas for intelligent budgetary control. The problems are more difficult, and emphasis may be changed for various types of costs. In budgetary control of engineering expense, for example, it may be necessary to allocate or budget manhours on a project basis. Further, the real control, aside from keeping expenses within budget—an appropriation type—would be a periodic review of the planned projects to see that the progress and probable gain from each is worth the expected cost. A similar approach may be found useful in the intelligent control of research and development expense, market research expense, or advertising expense. In general, all types of costs or income should be budgeted.

Finally, we come to the matter of motivation and stimulation in connection with a budgetary program. Because a budget is among other things, a device to control costs through *people* the human relations phase must be given more emphasis. We might even say that the human phase of budgetary control is as important as the technical phase. Getting budgets to work is a selling job, just as much so as selling your product. Too often budgets are resented because they are considered pressure tools. The trick is to sell the budget as a challenge, as a means by which competence may be demonstrated.

SELLING THE BUDGET

In considering the human aspects of budgeting, these points indicate the approach to be taken—an approach that does not relegate the budget program to the corner shelf:

1. The budget must have the full strength of the executive force behind it. All executives, major and minor, must know that the chief executive insists on the investigation, study, and decisions necessary to establish sound plans and make them work.

2. The lines of communication must be open from the top executive down to the lowest echelon. Too often plans are well conceived in the

executive committee meeting, but those who must execute simply don't know what is expected. Nothing so restrains the enthusiasm and energy of an organization as uncertainty.

3. *Cooperation* should be the key-word in *establishing* the budgets. The budget manager should avoid technical accounting jargon in helping the foremen and department managers establish their budgets. The budget should be viewed as the budget of the supervisor who will have the duty of controlling the costs—not an accounting budget, not something stuffed down the throat of the supervisor by a budget manager.

4. *Cooperation* should be the key word in reviewing actual *performance.* By and large, department managers and foremen take pride in the efficient operation of their departments. They usually want to do a good job, and will accept reasonable help. Therefore, in analyzing actual results, teamwork is needed.

5. Budget reports should be presented in a simple fashion and in such a way as to emphasize the important points and get the message to the man on the firing line.

This is an area where a little thought may be most rewarding. For example, a short narrative at the bottom of the report, in layman's language, about the managers' performance could be helpful. Or, unimportant accounts might be combined to avoid the appearance of a vast amount of detail. The report should of course, isolate the expenses that are important dollar-wise and that mean something to the reader. Too, if the department supervisor's name is put on the report, it might get better reception. Always we should keep in mind the viewpoint of the man who is to take corrective action. Let's try to make it *his* report.

By and large, a little imagination, a little common sense, a little technical knowledge, and a little of the right kind of human engineering will go a long way in making your budget program really effective.

55. FINANCIAL PLANNING AND CONTROL—THE KEY TO EFFICIENT MANAGEMENT

Edward W. Binshadler*

The author outlines the steps of a modern financial planning and control program. A "normal" volume concept is favored in planning and pricing.

* From *The Arthur Young Journal,* VI, 4 (1959), 30-37. Reprinted by permission of Arthur Young & Company.

"Financial Planning and Control" is the name given to a system which is being used to increase over-all management efficiency. The complete system covers all areas from basic cost reports at the foreman level to plans for capital budgeting, return on investment and over-all control at the top management level. It fosters the development and use of tools which will aid in answering practical operating questions such as: "Is the company getting its share of the market? Are prices set to obtain maximum profit? Is a satisfactory return on investment being realized over the complete economic cycle? What actions should be taken to assure optimum use of facilities, both in the intermediate and long-term future? In what areas are costs out-of-line and is corrective action necessary?"

The concept is still in its infancy for a vast majority of companies and, for them, its potentials are virtually unexplored. Financial planning and control can be used by any size or type of organization, and in degrees varying from a complete system covering decentralized departments and divisions to the development of a guiding philosophy for a single procedure. As a tool of management it can increase the efficiency of the organization as a whole or in each operation to which it is applied.

The basic components included in a system of financial planning and control fall into three categories:

1. Current operating controls
2. An annual program
3. Long-term objectives and plan of operations

CURRENT OPERATING CONTROLS

Current operating controls include such items as the regular financial statements, reports on direct labor, burden absorption rates, production schedules and material costs. These items are a basic requisite to any control system and involve the cost accounting system, overhead allocation methods, mechanized accounting and reporting, purchase analysis and stock control.

These reports are developed to give all levels of management the tools necessary for control in all areas. Out-of-line conditions are highlighted through comparisons with pre-determined standards, permitting corrective action at the earliest possible moment and leading to maximum efficiency in the day-to-day operations.

ANNUAL PROGRAM

After current controls have been installed an annual program must be established. The major sections of this program include:

1. Market analyses and volume studies
2. Expense budgets
3. Pricing
4. Profit budgets (including cash budgets)
5. Studies of assets employed and return on investment

MARKET ANALYSES AND VOLUME STUDIES

Through market analyses and volume studies, the basic framework for sales and production planning is established. Market analysis provides insights into both the immediate and long-term prospects for the total industry's sales of the company's products and, concurrently, helps determine the reasonable objectives for the company's portion of this total market. Based on these forecasts and objectives, volume studies are made to establish the production range that will be required to meet these potential sales. However, the production range is developed from a study of anticipated sales over the next three to five-year period, with an average for the full period being established as a "normal" volume.

The "normal" volume is then used in planning requirements for productive capacity. The relationship of planned volume to anticipated requirements usually calls for an average annual productive capacity in excess of the average anticipated sales. The purpose is, of course, to allow for peak periods of demand such as those that could occur seasonally. A typical ratio may call for normal straight-time capacity to equal 120% of the "normal volume." Additional requirements can then be met through the use of overtime or an increase in the number of shifts, depending upon such factors as costs, flexibility, long-term growth and anticipated expansion.

After "normal" volume has been determined, it is used as a guide in setting basic control standards in all areas—expense budgets, the allocation of fixed costs to units, price determination, the utilization of assets, the determining or measuring of return on investment, the planning of facilities requirements and the preparation of the profit budget. "Normal" volume is used both as a long-term target and as a current standard for review of variances.

EXPENSE BUDGETS

Budgets are prepared for all areas of operation (down to individual cost centers or sections) at the volume level that has just been discussed. First, a bill of materials must be prepared. This requires the preparation of the necessary design specifications from which the product will be built and the determination of the quantity and grade of material required. After this is done, and after management has determined which parts are to be produced and which purchased, the Works Standards or Industrial Engineering Department develops labor standards for each operation from historical data, supplemented as necessary by methods and time studies.

Finally, an overhead budget is prepared for each section controlled by an individual foreman, then for each department (comprised of several sections), and then for the plant as a whole. Each individual area of operation reflects the anticipated costs required to produce the "normal" estab-

lished volume. Although more will be said later about variable budgets, it should be noted here that significant advantages will accrue from a segregation of fixed and variable expenses and consideration should be given to breaking down the manufacturing costs into these two categories.

Similar budgets, varying in detail according to the type and size of organization, are established for other activities of the company. These may include such activities as staff and administrative groups, warehousing, engineering, distribution and sales operations. As in the case of manufacturing overhead, it is preferable that the costs for these functions be segregated between variable and fixed elements. In view of the constantly increasing automation of manufacturing activities, administration and other indirect labor costs are becoming an increasingly larger part of total costs. Since budgeting techniques for administration expense are relatively undeveloped in many companies, the opportunity for improvement in control here becomes apparent.

Another budget which should be considered is one for facilities. The anticipated expenses for labor, material and other manufacturing expenses are based on the present plant and equipment, combined with any changes that are planned for the next year. Also, certain facilities costs are considered as expenses and must be reviewed in conjunction with capital expenditures (based on considerations of tax savings and company policy). The annual program for this operation must naturally be treated as part of the longer-range program which is normally the guide for determining plant expenditures and must, of course, be compatible with the capital budget, the current cash position and the volume studies discussed earlier.

PRICING

Prior to incorporating the expense budgets into the profit budget, the sales pricing policy must be considered. This policy must obviously be established in terms of the particular industry, type of organization, product, etc. Regardless of the type of product, however, such factors as "normal" volume and cost estimates should be used in setting prices. Naturally, marketing considerations and competitive practices will also be governing factors. Nevertheless, in the final analysis three factors still influence prices: (1) meeting competition, (2) adjusting design to permit the manufacture of a product at a cost which will allow an adequate return to be earned on investment and (3) making provision for adequate funds to be available for continued operation and the replacement of facilities.

It is frequently deemed advantageous to base pricing practices on the "normal" volume concept. This method tends to permit approximately the same amount of fixed costs to be spread to individual units from year to year, thereby giving a greater degree of stability to the costs used for

pricing. By this means, pricing becomes an integrated part of over-all planning, directed toward earning an optimum return on investment over longer periods. Thus, full costs will be recovered over the normal volume cycle while, at the same time, a competitive advantage may be obtained during periods of low sales volume. Some manufacturers, who do not follow this practice, will price for full recovery of fixed costs on the basis of actual volume—thus leading to higher unit costs and prices in periods of low production. Use of the "normal" volume concept will permit quicker and more accurate estimates of the effect on profit of marginal sales where special price concessions are granted. Also, a determination of breakeven points at volumes anticipated over longer-term periods will permit management to make decisions on a planned basis, rather than on results influenced by short-term fluctuations in the business cycle.

PROFIT BUDGETS

All of the foregoing working tools that have been described (market analyses, volume studies, expense budgets and pricing policies) provide the groundwork for a comprehensive profit plan for the current year. This summary of operations and basic control document is a *pro forma* income statement for the next twelve months' period. Against it, by means of monthly statements, short-term forecasts, etc., actual operations are compared to see where results are out-of-line, what is causing the deviations and what corrective steps can be taken to keep operations up to or ahead of the original program.

As mentioned earlier, there are advantages in employing the variable budget technique whereby expenses are segregated into fixed and variable elements. As a result of classifying the accounts in the annual profit budget in this manner, a wide degree of flexibility is established. Budgeted costs can be adjusted to any desired level of operations and actual costs can be compared with budget at the actual sales or production volume. At the same time, the amount of variance from budget due to volume changes is automatically developed.

Along with these annual budget plans, controls and projections should be made to assure the adequacy of the day-to-day flow of cash, including consideration of such factors as payments, collections, financing, etc.

ASSETS EMPLOYED AND RETURN ON INVESTMENT

The final measurement tool used in the annual program is based on the assets employed and the return earned on investment. Although there are a number of methods for determining the amount for assets utilized, actual assets employed seems preferable to stockholder investment since general managers are responsible for the former. One principal point of debate is whether gross, net or some specific percentage of gross assets

should be used. Although space will not permit a detailed review of the pros and cons of the various methods, factors generally considered include such items as the relationship of the depreciation reserve to original cost, replacement cost, estimated life of equipment and ratio of current to fixed assets. Further, it is extremely important that serious consideration be given to any consistent practice used in the industry. This permits plans for prices and cost recovery to be based on the same objectives as those of competitors. Where there is more than one product, the asset base should be developed by product line and be used to judge annual profits before taxes by individual product.

Profit stated as a per cent of assets employed indicates the true performance of working capital and plant at the operating level and is frequently developed through a combination of the two following ratios: (1) sales divided by assets employed, reflecting the turnover of capital, and (2) net income divided by sales, or profit as a per cent of sales. When the first of these ratios is multiplied by the second, the result is the per cent return earned on investment. Through the use of these ratios performance is indicated both in the relationships of sales volume to assets and net income to sales, the latter an indirect measure of the efficiency of cost control. These measures are significant performance gauges in planning future expansion and plant investment, determining relative sales emphasis for various product lines and pointing out where further cost control is necessary.

LONG-TERM PLANNING

Long-term planning follows generally the same pattern as the annual program. A program for each area of operations (such as sales, production and purchasing) is developed for a three to ten-year period, indicating exactly where and how improvements can be made. Specific examples would include plans for improvement in sales volume, product mix and prices, improvement in direct labor efficiency, automation, better material usage and reductions in purchased material costs. The whole plan is developed to tie in with the current business cycle and is reviewed annually for revisions.

The detailed annual budget for each year's operations is developed and fitted into the long-term plan. The ultimate goal is to build a sound base for attaining optimum return on investment.

APPLYING THE SYSTEM

In addition to the comments on techniques, some discussion is required as to how the system functions and as to the guiding management philosophy that lies behind the plan. In discussing the profit budget, a comparison of actual performance with budget was mentioned. Such a variance

analysis is a prerequisite to the functioning of the complete system because it indicates where performance was better or worse than originally planned in the case of volume, product mix, material cost, direct labor, manufacturing overhead and other areas. These analyses are frequently prepared by the finance staff and reviewed currently with representatives of all departments of the company.

To pinpoint areas where corrective action is necessary the variance analysis is also compared with a forecast for a period of one to three months. This shorter-term forecast is prepared each month to reflect the latest conditions. This permits management to make decisions based on constantly changing conditions. By this analysis of differences between actual results and both the annual profit budget and short-term forecast a more complete picture of the immediate trend is shown and the places where corrective action should be taken are indicated.

There are a number of ways of informing management of the results of such variance analyses. Two of the more common are summary reports by operations and a periodic financial review. This latter method usually consists of a meeting of all department or operating heads, with a discussion of historical and current operations, a consideration of the latest forecast for anticipated results and an analysis of the reasons why the most recent results vary from the annual budget or prior forecasts. The discussions generated by these reviews are frequently the basis for specific decisions and the determination of long-term policy.

DECENTRALIZATION OF RESPONSIBILITY

In the above comments some of the more widely used forms of financial controls and some of the methods for putting them into effect have been explained. Although these techniques and the basic approach can be applied to an operation of any size, the system may need to be more highly developed in larger companies where operations are highly complex and diversified and are more difficult to control. This has led to a program of decentralization of responsibility while maintaining centralized control and to the development of concepts of "Responsibility Accounting" and "Management by Exception." Here, the system of controls must be developed to permit middle management to exercise initiative while over-all control is retained by top management.

In applying any form of financial controls some thought must be given to the very practical consideration of the ability of the company's personnel to utilize the plan. In addition to management being receptive to the objectives and general approach, key personnel in charge of developing and analyzing the data must have sufficient ability and understanding of the system to assure that full use is made of its potential. No "system" in itself will automatically assure a successful operation but the methods

which have been discussed here have been utilized by some of the country's most successful business enterprises.

56. FORECASTING FINANCIAL REQUIREMENTS

J. Fred Weston*

Professor Weston suggests the use of projected sales as a key figure in financial forecasting in a striking fashion. His method is illustrated, justified, and evaluated by using actual business data.

Forecasting financial requirements lies at the heart of accounting and financial decisions in the firm. All management decisions deal with the future and forecasting is inevitable. Some business managers are aware of this and some are not, which is equivalent to saying that some forecasting is good and some is bad. When decisions are made that involve the future, whether recognized or not, an implicit forecast is necessary.

METHODS OF PROJECTING FINANCIAL REQUIREMENTS

There are three main methods for projecting financing requirements. One is based on historical relationships and utilizes statistical methods. The second involves engineering analysis which is a combination of technical knowhow and judgment. A third involves an operation analysis, not necessarily technical in nature and relies mainly on judgment and understanding of the kinds of operations the firm engages in.

Obviously in this discussion, it would not be appropriate to attempt to present the techniques necessary for an engineering analysis. In addition, the kind of technical background required for an operations analysis differs from company to company. But omitting the technical approach, one finds a surprisingly useful, dependable and informative mechanism by simply projecting observed historical relationships. Indeed, this kind of analysis is fundamentally the basis for a budget program.

THE SIMPLE TRADITIONAL METHOD

The traditional approach to forecasting financial requirements expresses the firm's needs in terms of the number of days' sales tied up in an individual balance sheet item. For example, we may say that a firm will

* From *The Accounting Review,* XXXIII, 3 (1958), 427-40. Reprinted by permission of the publisher.

need to have five days' sales in cash, thirty days' sales in inventories, forty-five days' sales in receivables, and sixty days' sales in fixed assets. On the liability side, accounts payable may represent thirty days' sales. If a firm's net worth is the residual, the above information is enough to tell us what the firm's balance sheet will be, if the firm's sales were, for example, $2,000 per day.

The results are shown on the balance sheet for firm *A*.

Balance Sheet
Firm A

December 31, 1958

Cash	$ 10,000	Accounts Payable	$ 60,000
Receivables	80,000	Accruals	40,000
Inventories	100,000	Net Worth	210,000
Fixed Assets	120,000		
Total Assets	$310,000		$310,000

This brief example illustrates that there is a relationship between sales and the balance sheet items. Hence it shows the tie-in between forecasting sales and forecasting financial requirements.

One way to develop the relationships between sales and the individual balance sheet items would be to consider the relationship between the two growing out of basic business and engineering considerations. For example, suppose that Firm *A* sells on credit terms established by the line of business in which it operates at 40 days net. This firm would, therefore, expect to have something more than 40 days' sales in receivables because customers do not ordinarily pay precisely on time. Thus it might expect something like 42 to 45 days' sales in receivables.

Similarly, standards developed in production management analysis might indicate the necessity for 30 days' sales in inventories. Engineering analyses might establish the need for 60 days' sales in fixed assets.

The terms of trade on which the firm purchases raw materials may be assumed to average 30 days resulting in accounts payable of 30 $\times$ $2,000. Purchases per day might average, let us say, net 35 days in terms of *cost* of the materials, so that when expressed in relationship to sales the relationship might very well be 30 days' sales on the average in accounts payable.

Another method for discovering the number of days' sales in each of the balance sheet items may be used. This method consists of observing the actual relationships between sales and the individual balance sheet items for selected years.

The calculation of the number of days' sales in the major balance sheet items is a dependable method for projecting financial requirements in

some instances, but not in others. Another method which is widely used is that of correlation analysis. This method is somewhat complex but is relatively easily understood and provides a powerful tool for analysis.

The great advantage of the correlation method is that where the number of days' sales in receivables or inventories, for example, changes over a period of years it still provides a very useful resulting figure for projection. The correlation technique is a method of using average relationships which provides an average which is useful in the future as contrasted with an average which is not meaningful for the future. This can be demonstrated by the following simple example.

In the material presented in Table 1, the number of days' sales in inventory drops from 12 in 1954 to 5 in 1958. The use of 5 as the figure for projecting inventory needs in 1959, or an average of the numbers is likely to be misleading in view of the trend developing.

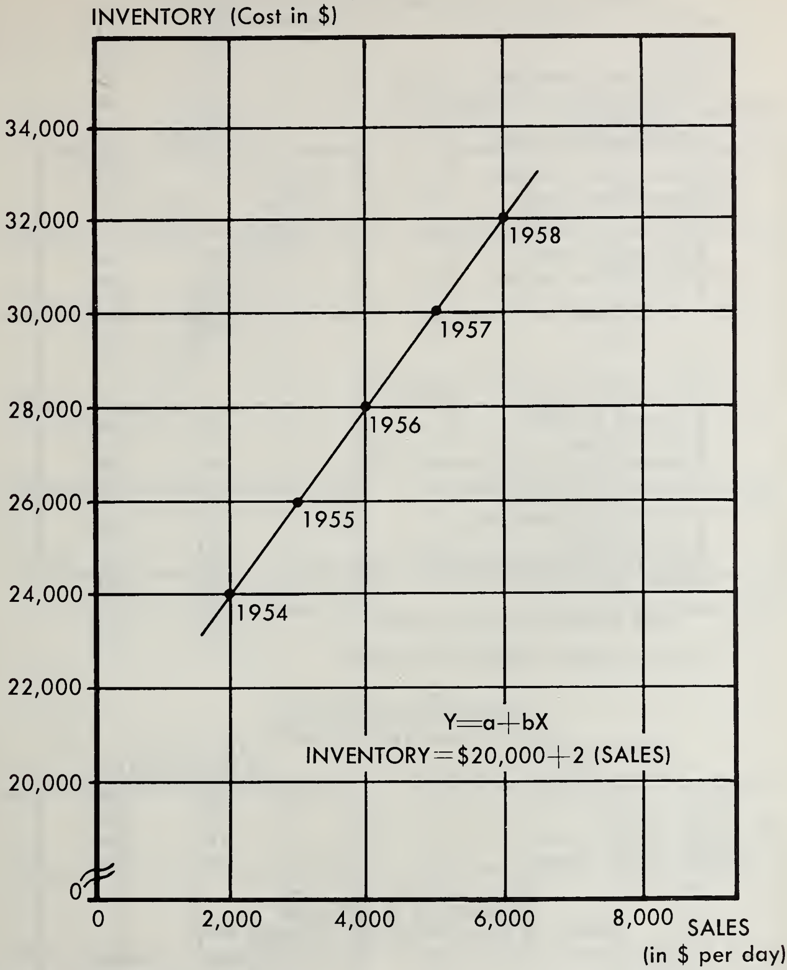
TABLE I

Year	*Sales per Day*	*Inventory at Cost*	*Number of Days' Sales in Inventory*
1954..........	$2,000	$24,000	12.0
1955..........	3,000	26,000	8.67
1956..........	4,000	28,000	7.0
1957..........	5,000	30,000	6.0
1958..........	6,000	32,000	5.0

Correlation analysis furnishes a method for forecasting inventory needs which avoids difficulty. This is illustrated in Chart I. When the data from Table 1 are plotted on Chart I, it is clear that a definite relationship exists. This relationship can be observed as follows; the change in inventory between 1954 and 1958 is $8,000.00, the change in sales for the corresponding period is $4,000.00. Eight thousand divided by 4,000 yields 2, which tells us the slope of the line. This enables us to obtain an equation readily either by reading the basic inventory amount off the chart at $20,000.00 or from an equation relationship. Since this is a straight line equation it has the form $Y = a + bX$. In our case Y is inventory or the dependent factor and X is sales, the causal factor. The letter b stands for the slope of the line which we know is 2. Therefore, we can use the inventory and sales of any year and solve the equation for a. To illustrate: in 1958 sales are 6,000 and inventory is 32,000. Thus, two times sales per day of 6,000 is 12,000, inventory is 32,000; 32,000 less 12,000 is 20,000. The a in the equation is therefore equal to 20,000 and is a fixed amount which does not change. Thus our equation for the relationship between inventory and sales is:

FORECASTING FINANCIAL REQUIREMENTS

CHART I. CORRELATION BETWEEN SALES AND INVENTORY



inventory is equal to $20,000 plus two times whatever our level of sales per day happens to be. Inventory = $20,000 + 2 Sales.

It will be observed that, although the number of days' sales in inventory changes, this regression equation ($Y = a + bX$) enables us to predict in a fairly dependable fashion what the inventory will be for any given level of sales.

Thus far we have presented a very simplified illustration of the correlation method for projecting financial requirements. An actual example is now presented for the Standard Oil Company of California.

Standard Oil of California
Balance Sheet

(Figures Rounded to the Nearest Million Dollars)

ASSETS		*1950*		*1955*
Cash		67		110
Marketable Securities		77		32
Notes and Accounts Receivable		93		196
Inventories		97		175
Other Current Assets		—		—
Total Current Assets		334		513
Gross Fixed Assets	1504		2336	
Reserve for Depreciation	651		1066	
Net Fixed Assets		852		1270
Miscellaneous Assets		46		72
Total Assets		1232*		1855*

LIABILITIES AND NET WORTH	*1950*	*1955*
Accounts Payable	59	141
Notes Payable	—	—
Provision for Federal Income Taxes	60	58
Other Current Liabilities	26	30
Total Current Liabilities	145	229
Long-term Debt	95	79
Retained Earnings plus Surplus Reserves	418	751
Capital Stock	571	791
Total Liabilities and Net Worth	1229*	1850*

* Do not balance because of rounding.

Standard Oil of California
Income Statement Information

	1950	*1955*
Sales	816	1278
Sales per day	2.27	3.55
Profit Before Taxes	217	290
Profit After Taxes	151	231

Standard Oil of California
Number of Days' Sales in the Following Items

	1950 days	*1955* days
Cash	30	31
Receivables (Net)	41	55
Inventories	43	49
Total Current Assets	147	145
Fixed Assets (Net)	375	358
Total Assets	543	523
Accounts Payable	26	40
Notes Payable	—	—
Current Liabilities	64	65
Long-term Debt	42	22
Preferred Stock	—	—
Net Worth (Common Stk. and Ret. Earn.)	436	434

FORECASTING FINANCIAL REQUIREMENTS

CHART II. STANDARD OIL COMPANY OF CALIFORNIA SCATTER DIAGRAMS

FOR ESTIMATING FINANCIAL REQUIREMENTS

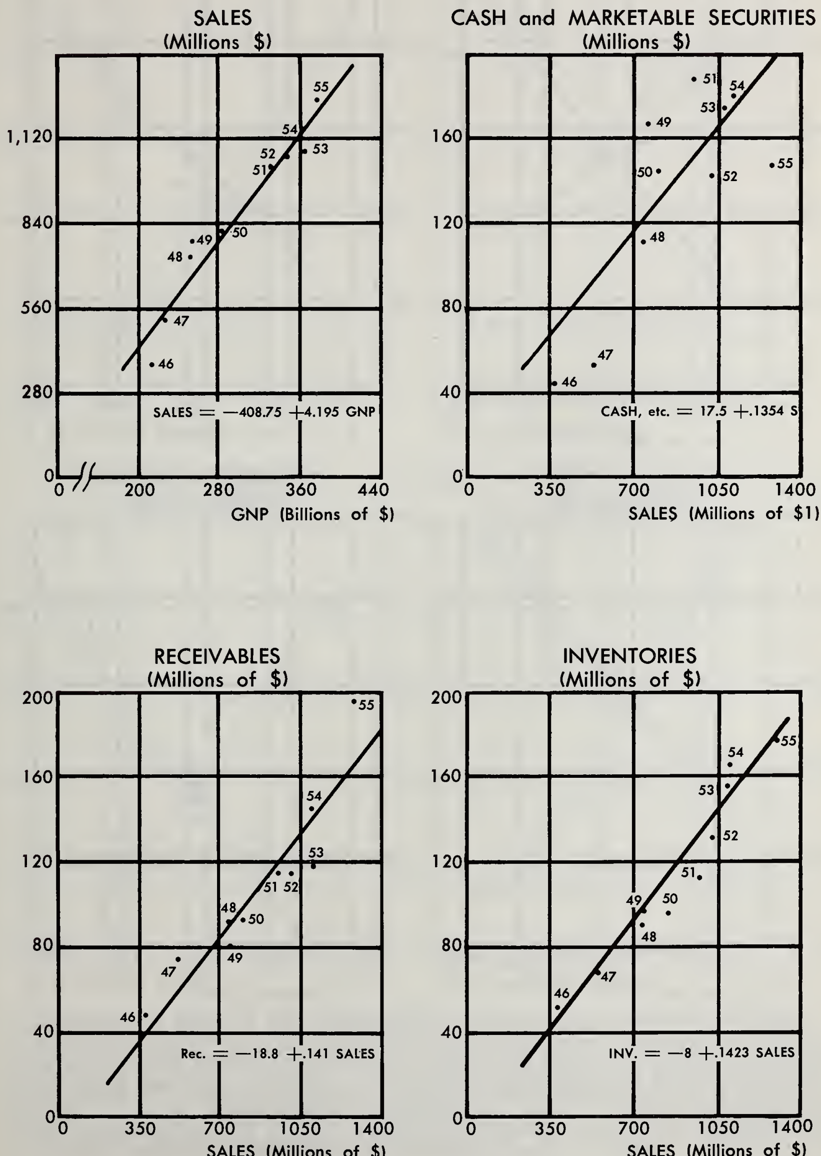


CHART II. STANDARD OIL COMPANY OF CALIFORNIA SCATTER DIAGRAMS FOR ESTIMATING FINANCIAL REQUIREMENTS—(*Continued*).

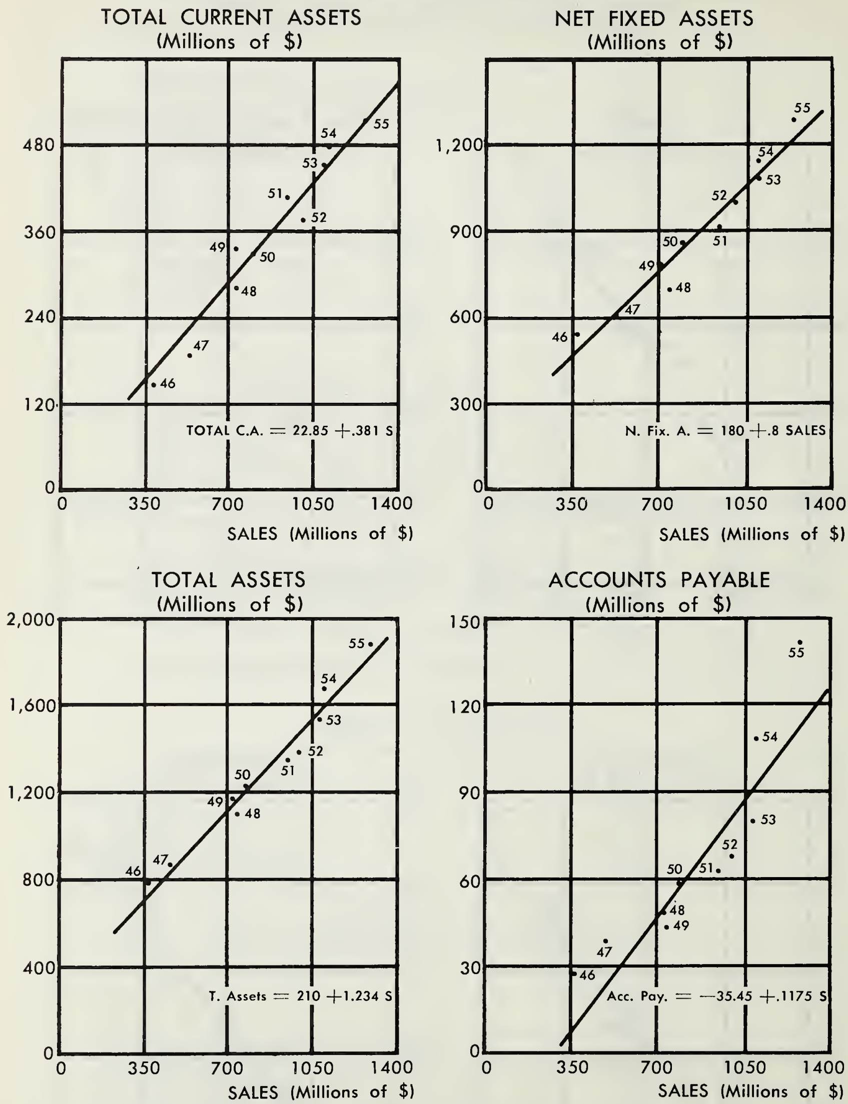
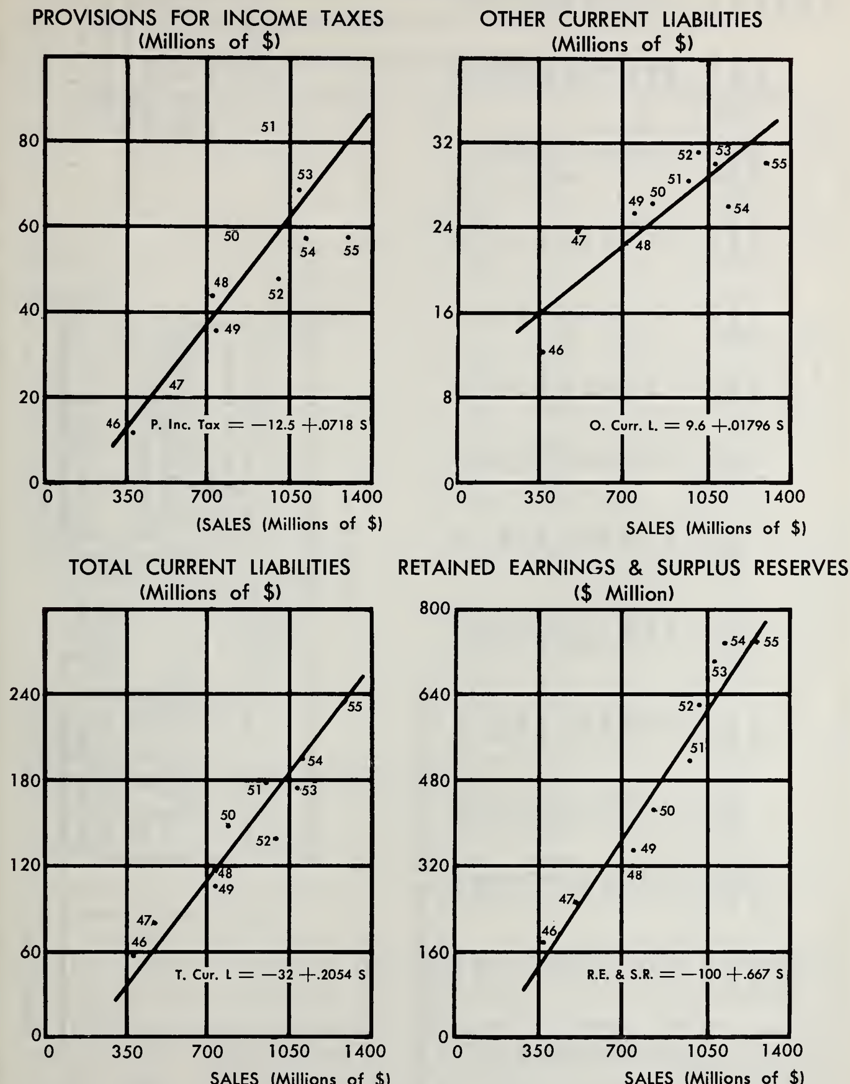


Chart II demonstrates how the relationships can be used to project financial requirements into the future. In the case of Standard Oil of California, using the regression relationships through 1955 and projecting for 1956 data which are now available, we can compare the accuracy of the forecast (Tables 2, 3). We find quite dependable results. With this

CHART II. STANDARD OIL COMPANY OF CALIFORNIA SCATTER DIAGRAMS FOR ESTIMATING FINANCIAL REQUIREMENTS—(*Continued*).



method we are able to calculate the amounts needed to finance asset requirements. We observe how much of this financing is provided from trade credit in accounts payable. This indicates the amount of additional external financing that will be required over and above the amount by which retained earnings will increase from profits.

TABLE 2

STANDARD OIL COMPANY OF CALIFORNIA DATA SHEET

	GNP	*Sales*	*Cash and Marketable Secur.*	*Receivables (Net)*	*Inventories*	*Total Curr. Assets*	*Net Fixed Assets*	*Misc. Assets*	*A/C's Payable*	*Prov. for Inc. Tax*	*Other Curr. Liab.*	*Total Curr. Liab.*	*Long-term Debt*	*Common Stock*	*Ret. Earn. and Surp. Reserves*	*Tot. Asset and Claims on Asset*
1946....	209.2	373	45	50	50	148	520	117	28	12	12	58	-0-	492	179	785
1947....	232.2	530	50	74	65	189	606	80	41	20	24	86	45	492	253	876
1948....	257.3	736	110	87	89	286	690	99	47	44	23	114	107	530	324	1075
1949....	257.3	743	168	80	94	341	773	44	42	36	25	104	140	571	342	1158
1950....	285.1	816	144	93	97	334	852	46	59	60	26	145	95	571	418	1233
1951....	328.2	975	188	110	113	410	903	52	63	87	28	177	95	571	517	1366
1952....	345.4	1015	138	109	133	381	977	49	66	49	31	146	85	571	604	1407
1953....	363.2	1080	173	119	156	449	1038	49	78	67	30	175	79	571	709	1535
1954....	360.7	1113	177	132	165	474	1138	66	106	58	26	192	78	676	731	1678
1955....	390.9	1278	142	196	173	512	1270	72	141	58	30	229	79	797	751	1856
1956....	412.4	1567	137	224	200	562	1394	85	157	63	34	254	76	797	914	2041

Source: Company Annual Reports and Moody's Industrials.

TABLE 2a

STANDARD OIL COMPANY OF CALIFORNIA REGRESSION FORMULAS

Sales	$= -408.75 + 4.195$ (GNP)	Accounts Payable	$= -35.45 + .1175$ Sales
Cash and Marketable Securities	$= 17.5 + .1354$ Sales	Provision for Income Taxes	$= -12.5 + .0718$ Sales
Receivables (Net)	$= -18.8 + .141$ Sales	Other Current Liabil.	$= 9.6 + .01796$ Sales
Inventories	$= -8 + .1423$ Sales	Total Current Liabil.	$= -32 + .2054$ Sales
Total Current Assets	$= 22.85 + .381$ Sales	Long-term Debt	Assumed a fixed amount, the average of last 10 years or 80 million
Misc. Assets	Assumed a fixed amount, the 10 year average or 67 million	Common Stock	$= 298 + .33$ Sales
Net Fixed Assets	$= 180 + .8$ Sales	Retained Earnings and Surplus Reserves	$= -100 + .667$ Sales
Total Assets	$= 210 + 1.234$ Sales		

TABLE 3

STANDARD OIL COMPANY OF CALIFORNIA

PERCENTAGE OF ERROR IN THE 1956 ESTIMATES

(Using Actual Sales and Also Projected Sales)

	1956		% Error (2—1) / (1)	1956 Estimate Based on Actual Sales	% Error (4—1) / (1)
	Actual Figures	Estimated Sales			
	(1)	(2)	(3)	(4)	(5)
Sales	1,567	1,321	16	1,567	0
ASSETS					
Cash and Marketable Securities	138	196	42	230	67
Net Receivables	224	168	(25)	202	(10)
Inventories	200	180	(10)	215	8
Total Current Assets	562	544	(3)	647	15
Misc. Assets	85	67*	(21)	67*	(22)
Net Fixed Assets	1,394	1,237	(11)	1,434	3
Total Assets	2,041	1,848	(9)	2,148	5
LIABILITIES					
Accounts Payable	157	120	(24)	149	(5)
Provisions for Income Taxes	63	82	30	100	6
Other Current Liabilities	34	33	(3)	38	12
Total Current Liabilities	254	235	(7)	287	13
Long-term Debt	76	80*	5	80*	5
Total Liabilities	330	315	(5)	367	11
Capital					
Common Stock	797*	797*	0	797*	0
Retained Earnings and Surplus Reserves	914	781	(15)	945	3
Total Capital	1,711	1,578	(8)	1,742	2
Total Liabilities and Capital	2,041	1,893	(7)	2,109	3

* Assumed a Fixed Amount.

The amount of additional financing that will be required can be observed from the pattern of the relationships. All of the asset items are increased in a relatively systematic fashion in response to the sales increase. On the right-hand side of the balance sheet accounts payable will expand in accordance with expansions of trade credit. Provision for Federal Income Taxes and retained earnings will each increase by approximately one half of earnings before taxes and retained earnings will increase by approximately one half of profits after taxes since dividend pay-outs for American industry are characteristically now around 50%. The extent to which a growing firm will need to finance its asset increases by more than

trade credit, depreciation charges, provision for Federal Income Taxes and retained earnings will be indicated by the projections based on the regression relationships. The amount of external financing required can, therefore, be planned for and steps taken to procure the necessary amount of external financing. This is illustrated in Table 4.

This method for projecting financial requirements can be performed both at a level of the firm, the industry, or for the economy as a whole.

TABLE 4

STANDARD OIL COMPANY OF CALIFORNIA

PRO FORMA BALANCE SHEETS

1956 ESTIMATES COMPARED WITH 1956 ACTUAL

ALSO 1957-60, 65 ESTIMATED

(Estimates Calculated from the Regression Equations)

	*1956 Actual**	*1956 Est.*	*1957 Est.*	*1958 Est.*	*1959 Est.*	*1960 Est.*	*1965 Est.*
Gross National Product ($ billions)	412.4	412.4	433	454.7	477.4	501.3	641
Company Sales ($ millions)	1,567	1,321	1,408	1,499	1,594	1,694	2,280
Assets							
Cash and Marketable Securities ..	138	196	208	220	233	247	326
Net Receivables	224	168	180	193	206	220	303
Inventories	200	180	192	205	219	233	316
Total Current Assets	562	544	580	618	658	700	945
Misc. Assets	85	67	67	67	67	67	67
Net Fixed Assets	1,394	1,237	1,306	1,379	1,455	1,535	2,004
Total Assets	2,041	1,848	1,953	2,064	2,180	2,302	3,016
LIABILITIES							
Accounts Payable	157	120	130	141	152	164	232
Provision for Income Taxes	63	82	89	95	102	109	151
Other Current Liabilities	34	33	35	37	38	40	51
Total Current Liabilities	254	235	254	273	292	313	434
Long-term Debt	76	80	80	80	80	80	80
Total Liabilities	330	315	334	353	372	393	514
CAPITAL							
Common Stock	797	797	797	797	797	797	797
Retained Earnings and Surplus Reserves	914	781	839	900	963	1,030	1,421
Total Capital	1,711	1,578	1,636	1,697	1,760	1,827	2,218
Sub-Total (Liabilities and Capital)	2,041	1,893	1,970	2,050	2,132	2,220	2,732
Additional Financing Needed ...	0	−45	−17	14	48	82	284
Total	2,041	1,848	1,953	2,064	2,180	2,302	3,016

* Source: Annual Report, 1956, Standard Oil Company of California.

TABLE 5

Regression Equations:

Cash = 10 + 1S	Accounts Payable = 20 + 1S
Receivables = 20 + 2S	
Inventory = 30 + 3S	Other Current Liabilities = 10 + 2S
Net Fixed Assets = 50 + 4S	Capital Stock
	Retained Earnings = 44 + .02S

Sales per day: S = Sales per day
1958 Sales per day equal $2,000
1965 Sales per day equal $5,000
Balance Sheets:

Balance Sheet, 12/31/58
($000 omitted)

Cash	12	Accounts Payable	22
Receivables	24		
Inventory	36	Other Current Liabilities	14
Fixed Assets	58		
			36
		Capital Stock	50
		Retained Earnings	44
	$130		$130

Balance Sheet, 12/31/65
($000 omitted)

Cash	15	Accounts Payable	25
Receivables	30	Other Current Liabilities	20
Inventory	45	Capital Stock	50
Fixed Assets	70	Retained Earnings	44
		Financing required	21
	$160		$160

Since the method may be difficult to follow in an actual example, another illustration is developed which shows the method more simply. We assume a firm with the following beginning balance sheet. This is shown in Table 5. This balance sheet reflects the regression equations set up initially, for cash is equal to $10,000 plus one times sales; receivables are equal to $20,000 plus two times sales, and so forth.

Nineteen hundred fifty-eight sales per day are equal to $2,000 and 1965 sales per day are assumed to equal $5,000. Based on the sales per day of $2,000 and the regression equations, the balance sheet at the end of 1958 is indicated. In this balance sheet capital stock and retained earnings are assumed amounts.

The balance sheet for 1965 is shown based on the regression relationships and the assumed average sales per day of $5,000. The asset items increase to $160,000 and accounts payable increase to $25,000.

Observation of the projected balance sheet as of the end of 1965 shows that, if capital stock and retained earnings remain unchanged, the amount of additional financing required would be $21,000. This is a relatively small amount for this situation. It is likely that it would be obtained from retained earnings. However, it is important to recognize that even this

represents a financing decision, a decision to keep moneys in the business which might otherwise be distributed to its owners.

Thus the method of correlation analysis indicates how relatively dependable projections may be made of financing needs, not only on a year to year basis but for the longer term projections of five to ten years which are essential in planning for the acquisition and use of capital facilities.

NUMBER OF DAYS' SALES METHOD COMPARED WITH REGRESSION ANALYSIS

The two leading methods of projecting financial requirements have been set out. It may be of interest to compare the results using the two methods for a sample of firms. Accordingly, we selected ten firms representing a cross section of industries to compare the use of the two methods. This comparison is shown in Table 6. The average per cent error using the regression method for cash is 41 compared with 58 for the average number of days' sales method. For receivables, the corresponding errors are 21 and 19; for inventories, 11 and 19; for gross fixed assets, 15 and 20; for accounts payable, 13 vs. 19. These projections were based on the years 1950 to 1955, a period of time during which the sales increases of the ten firms analyzed was substantial. The margin of error is relatively large for both but much smaller for the regression method than for the average days' sales approach.

The errors are reduced substantially when the calculations are based on actual sales rather than estimated sales. This is shown by Table 7.

Furthermore, analysis of Tables 6 and 7 reveals that the large average errors are usually caused by erratic results in one or two companies. But the average error is small in numerous instances.

A comparison of the two leading methods for projecting financial requirements indicates that both are subject to relatively large margins of error. For more dependable forecasting, additional analysis must be carried out, based upon engineering relationships and the characteristics of the line of business. For example, knowing the terms of credit or terms of sale for a particular industry will enable one to make a reasonably dependable judgment or forecast about a number of days' sales and receivables. For example, if the firm's terms of sale were net 30 days, it is likely to have about 32 to 35 days' sales in receivables since on the average firms will take more than 30 days to pay, allowing for some spillover beyond the required payment date.

Similarly, standards have been worked out for many industries, indicating the normal amount of inventory per dollar of sales. Where available, they could of course be used as a guide for adjusting the forecast figures.

TABLE 6

SUMMARY

BALANCE SHEET DATE FORECAST ERROR

	Cash Equivalent		*Receivables*		*Inventories*		*Net Fixed Assets*		*Accounts Payable*	
	% Error		*% Error*		*% Error*		*% Error*		*% Error*	
	Regression	*Days' Sales*	*Regression*	*Days' Sales*	*Regression*	*Days' Sales*	*Regression*	*Days' Sales*	*Regression*	*Days' Sales*
Continental Can	+13	−30	−5	+8	−3	+20	+3	+14	−14	−29
Crown-Zellerbach	+8	+2	−8	−9	−15	−25	+9	−9	+4	+15
Du Pont	0	+6	−11	−1	−3	−4	0	+4	+10	+8
Fruehauf	−28	−26	−13	−22	−48	−33	−51	−33	+7	+21
Garrett Corp.	+73	+88	−13	−18	−10	−15	−24	−3	+15	+21
IBM	+71	+62	−27	−28	+1	+9	+23	+12	−15	−17
Jones and Laughlin	−20	−23	−31	−18	0	+21	−6	+12	−29	−37
National Lead	+25	−10	−2	−32	−1	−20	0	−27	−4	−30
North American	−30	−32	−76	−32	−37	−41	−54	−50	−42	−43
Raytheon	+43	+112	−10	−14	−8	−11	−24	−26	+10	−16
Sears, Roebuck & Co.	+1	+87	−38	−34	−12	−9	−5	−5	+3	+4
Sylvania	+90	+62	−5	−7	+1	−17	−8	−31	0	−9
U.S. Steel	−1	+60	−17	−13	−1	+20	+5	+31	−2	−5
Westinghouse	+173	+232	−42	−23	+16	+9	+1	+20	+21	−3
Average	41	58	21	19	11	19	15	20	13	19

TABLE 7

SUMMARY

BALANCE SHEET DATA FORECAST ERROR BASED ON ACTUAL SALES

	Cash Equivalent		Receivables		Inventories		Net Fixed Assets		Accounts Payable	
	% Error		% Error		% Error		% Error		% Error	
	Regression	Days' Sales	Regression	Days' Sales	Regression	Days' Sales	Regression	Days' Sales	Regression	Days' Sales
Continental Can (1956 Figures Adj'd) ..	+ 45	+ 55	−15	−30	− 3	−10	− 6	−15	−14	−22
Crown-Zellerbach	+ 8	+ 16	− 8	+ 5	−15	−14	+ 9	+ 5	0	+25
Du Pont	0	+ 6	−11	− 1	− 3	− 4	0	+ 4	+10	+ 8
Fruehauf	− 6	− 7	+ 3	− 2	−42	−17	−49	−17	−30	+34
Garrett Corp.	+ 91	+107	−10	−10	− 1	− 6	−17	+ 7	+24	+27
IBM	+ 71	+ 68	−27	−28	+ 1	+11	+23	+12	−15	−17
Jones and Laughlin	− 13	− 14	−26	− 6	+ 8	+35	+ 5	+26	−25	−58
National Lead	+ 32	− 5	+ 2	−29	+ 5	−15	+ 5	−24	0	−19
North American	− 5	− 5	+15	− 3	−13	−16	−36	− 4	−20	−18
Raytheon	+ 43	+112	−10	−14	− 8	−11	−24	−26	+10	−16
Sears, Roebuck & Co.	+ 1	+ 88	−38	−34	−12	−10	− 5	− 8	+ 3	+ 3
Sylvania	+ 80	+ 56	− 8	−24	0	−16	−11	−31	− 3	− 9
U.S. Steel	− 1	+ 62	−17	−11	0	−22	+ 7	+33	− 2	− 4
Westinghouse	+102	+151	−49	−42	− 8	−17	−21	− 9	− 8	−20
Average	35.6	53.7	17.1	17.1	8.5	14.6	15.6	16.1	11.7	20.0

CONCLUSIONS

This paper has set out a description of another method in addition to the one more traditionally used by accountants in projecting financial requirements. This method has been shown to yield improved projections especially in regard to the five to ten year projections, the kind which is being increasingly employed by business firms in planning their needs for fixed asset requirements over a long period of time. Planning for financial requirements over a long period of time is essential for the successful conduct of business operations.

Neither of these methods is likely to yield completely dependable results. Regression analysis at the level of the firm as a whole has been found to be accurate within 5 to 10% in a large number of cases. However, this accuracy depends upon the stability of the relationships, which in turn depends upon the nature of the business. The use of correlation methods for projecting financial requirements is therefore subject to some error. However, it is still of value as a first stage in the analysis and can carry the forecaster a long way in making a first estimate of future needs. These estimates then can be supplemented by engineering analysis, by detailed understanding of the operation of the company, and subjective judgments.

It is to be noted that, if refinements are possible, they can be built on to the initial estimates made by use of correlation analysis. However, if there are no other ways of making refinements, it must be acknowledged that the use of correlation analysis provides much guidance.

The correlation method has been shown to be more dependable than the use of the average number of days' sales in receivables, inventories, etc. Thus it should provide a useful addition to the accountant's tool box of devices that he can use to increase his contribution in providing data for management of a business enterprise.

Section D:

CONTROL AND THE ACCOUNTANT

In the area of executive action the accountant has a genuine control function. Break-even analysis brings the accounting executive close to basic economic concepts, inasmuch as the objective of management—maximizing of profits—is a salient factor in both the accounting action and economic theory. Prior to any attempts at break-even charting, it is advisable, if possible, to establish theoretical total revenue and total cost curves for the business enterprise in accordance with the economic principles applicable. The accountant must make clear the underlying assumptions and limitations of break-even charts.

The break-even charts are the cost-volume side of the price-volume, cost-volume equation. In hastening delivery of a management report, internal relationships between components of the revenues and expenses must not be ignored. Thus, the point at which the total revenue line crosses the total cost line is known as the break-even point; at this level of production and sales the enterprise will have neither net income or net loss. Break-even analysis is usually thought of as a short-run concept and probably will be found to be more useful in short-run planning than in long-run decision making, since the forecast of revenues and expenses tends to become more unreliable the longer the period covered in the projection. Of greatest importance is the placing of emphasis in planning on the relative profitability of alternative courses of action rather than on the break-even point.

The next logical step based on the break-even charts is the development of a profit plan. One of the major advantages of developing and using a profit plan is that future

decisions concerning the addition of products or facilities, or the making of other expenditures, may be based on the effect of such moves upon return on stockholders' equity or total assets. Once the profit goal has been established, the most expeditious way of achieving it must be determined. This requires knowledge of the enterprise's product position in the market, its long-run sales expectancy, and the price at which that sales volume can be realized. Thus, if the budget is realistic and ties into the profit goal, and if the operations are planned in advance each month so that expenses are limited to those justified by the volume of production, the enterprise will be well on the way toward accomplishment of its profit objective.

The proper establishment, and acceptance by those executives appointed to assume responsibility for control and supported by the top administrative officials, of a budget control program is a means by which a profit can be realized from holding variable manufacturing expenses in line. In order for the control system to remain dynamic, it is extremely important that the top administration give its full and enthusiastic support and cooperation to the operation of the system. At the same time, management must receive pertinent, timely, and brief but factual information regarding the progress of different manufacturing units toward meeting their standards.

The decision-making process involves action which must be taken in the future. Such action involves the evaluation of the factual data and qualitative factors and the determination of their effect on the business or the particular problem. The accounting executive must continue to do a good and constantly improving job of internal reporting and forecasting. The accountant can and should participate in the making of external as well as internal forecasts, for his experience in the internal economic operations of the enterprise can be most useful in the external forecast. If the accountant assumes increasing responsibilities for the external forecasting of the firm, he will broaden the scope of his responsibilities and fulfill the natural implications of his function on the management team.

Increasing evidence of the accountant as a part of the internal management team can be found in the extensive growth of the controller concept. The major emphasis upon quantitative data, to be handled logically in the honest at-

tempt to be impersonal and objective in reports and analyses, is a primary characteristic of the accounting mind. In this process the controller continues to call management's attention to the consequences of daily activities through the emphasis upon the long-run or ultimate effects of current activities. The controller then has the responsibility of using the accounting procedures as a means of following up and checking upon management decisions. One of the most valuable services the controller can perform for his fellow administrators is to help them put their plans into such form, and to match the actual performance against those plans on an independently impersonal physical or quantitative basis. This view of his function recognizes that the primary reason for the existence of managerial accounting in any form is the use that management can make of it.

The area in which much has been done by the accounting executive is cost analysis. One helpful concept in analysis is marginal costing, which may be defined as an estimation of the amount, at any given volume of production or output, by which aggregate costs are changed if the volume of production or output is increased by one unit. The main feature of a marginal costing system is the separation of a business's variable costs from its fixed costs, and the control of each type by varying methods, so as to give maximum efficiency, and to reveal the effect upon profit of changes in output. The marginal costing also enables management to achieve the maximum net income during a given period by concentrating upon obtaining the maximum contribution per unit of the element of cost in short supply.

The distribution cost analysis phase of cost analysis has come into prominence because these costs have tended to rise, and the achieving of greater distribution efficiency has become an increasingly important objective for more and more companies that are forward-looking. When a company succeeds in increasing its distribution efficiency, it is able to make more goods available to more people at lower prices. The performance of specific marketing activities, the determination of the costs and profits for various segments of the distribution system, and the techniques used by the individual business concern to make analysis, has become known as distribution cost analysis. Distribution cost analysis may then be used by executives as an aid in determining profitable objectives for the enterprise, in set-

ting policies and procedures of operation, and in measuring the profitability of operation in individual segments of the firm. It is in the area of distribution cost analysis that marketing and accounting executives should make an effort to become more fully conversant with their mutual problems in developing and applying distribution cost figures.

Business executives need more information in a form they are able to understand. Cost accountants have developed systems that provide management with some information, usually timely and useful, but frequently little understood by administrators. Direct costing, a new concept, is a step in the direction of making more understandable cost analysis. The essential difference between absorption costing and direct costing is that the first emphasizes the distinction between production costs and all other costs whereas the second emphasizes the distinction between fixed costs and variable costs. Moreover, absorption costing tends to stress inventory valuation whereas direct costing is primarily concerned with cost analysis.

Direct costing has been devised to produce useful statements more easily understood by management. It shows clearly, without requiring any additional work, the cost-volume-profit relationship. As the profit figure is not influenced by the fixed costs which must be incurred whether the facilities are producing at full capacity or not, direct costing makes administrators more conscious of the importance of costs.

XV

BREAK-EVEN ANALYSIS AND VARIABLE BUDGETING

57. DISCLOSURE OF ASSUMPTIONS—KEY TO BETTER BREAK-EVEN ANALYSIS

Clayton W. Anderson*

In spite of the wide interest in break-even analysis, practical illustrations are fairly rare. The author discusses an application and appraises the limitations and usefulness of the break-even data employed.

Break-even analysis brings the accountant close to basic economic concepts.

The objective of management—maximizing of profits—is a salient factor both in advanced accounting and economic theory. For this reason, any study of profit maximization affords the accountant a chance to blend applied theoretical planning from both realms with experience and operating skill. Therefore, prior to any attempts at break-even charting, it is advisable, if possible, to establish theoretical total revenue and total cost curves for the enterprise in accordance with the economic principles applicable.

Further, the accountant can perform real service by directing management attention toward the assumptions underlying its break-even charts.

* From *National Association of Accountants Bulletin*, XXXIX, 4 (1957), 25-30. Reprinted by permission of the National Association of Accountants.

Pricing, lines of service or products, concepts of organization and the indirect functions of the business—all may be profitably scrutinized before the break-even chart is "frozen" unduly by the usual assumptions. However, the assumptions needed must be established eventually. Some of the most common assumptions made are that:

1. Sales prices (usually stipulated to the accountant by management) will remain constant.
2. Sales mix will remain constant.
3. Production will reasonably follow the sales pattern.
4. Costs can be classified into fixed and variable elements.
5. Variable costs will vary in a constant ratio.
6. Fixed costs will remain constant.
7. Direct labor and machine efficiency will remain relatively constant.

A CASE IN POINT: COMPANY BACKGROUND

Both the broad approach and the practical assumptions may be illustrated in terms of a small company. The case selected is a midwestern professional consulting firm with a New York office. All names, figures, and organization titles have been disguised. Started in 1924 by its woman founder, Business Research, Inc., undertook to perform all types of research which large business might demand, with particular emphasis on surveys and audits of markets, personnel, stockholder relations, and industrial statistics. The company soon built up a long list of satisfied clients. The president and professional staff members wrote articles and books, conducted conventions and seminars, and published monthly research newsletters. Incidental revenues were obtained from these activities. Despite its excellence of service the profits of the company fluctuated substantially.

There were three classes of women employees. The top group was highly skilled, well-educated, and had ten or more years of consulting experience. Having been hired permanently, these women received full salary whether or not on assigned or billable time. The second group consisted of former first-group personnel now married. These were retained on a temporary or periodic basis and paid for time worked. The third group was composed of evening workers. The full-time (1956 figures were six in Chicago and three in New York) and periodic staffs of professionals were the principal source of consulting services. Each was billed at $250 per week. The management did not consider evening work a primary source of revenue. Hourly rates charged the client and the salaries paid the evening workers were less than the day rates. Demand for their services, although frequently substantial in amount, fluctuated a great deal.

In the view of management, a major operating problem was the severely limited supply of full-time professionals capable of satisfying the high

skill and experience requirements. In order to hold turnover and layoffs to a minimum, the company employed these individuals during all seasons, whether or not their time could be billed. Frequently, to make a sale, the company had to assign personnel at the convenience of the client when optimum staff scheduling involved other work. Where such conflicts were substantial, the company would attempt to postpone the beginning of an engagement, but this was frequently out of the question.

THE 1956 ANALYSIS

Early in 1956, the president instructed the company accountant to outline briefly the level at which the company must operate during the year to meet expenses. The accountant produced a break-even chart with typical promptness. Costs were classified as to fixed and variable, revenues per billable hour were ascertained, and sales mix, and fixed costs were assumed to remain constant, etc. Further, the assumptions listed at the start of this article were made but not commented upon in the analysis, apparently because they were taken for granted. Equal distribution of work throughout the year and maintenance of professional staff were also implied. Certain other assumptions were specified:

1. Working days—230 per year (365 less 104 weekend days, 6 holidays, 10 vacation days, and 15 allowed for seminars, personal and other).

2. Available capacity, 1380 monthly work hours (9 members of professional staff at 8 hours a day for 230 days, divided by 12).

3. Net realization per hour—$6.025 (weekly billing of $250, divided by 40, less average hourly commissions of $.225).

4. Fixed costs were based on current monthly salaries, depreciation, and professional service costs, plus other expenses at 1955 totals per books, plus known percentage increases where available.

5. Revenues were projected on billings at $6.025 per hour and effective percentages of time billed, with corresponding wages of professional full-time consultants at $2.40 per hour, the current average.

6. Income and costs of evening work were excluded from the analysis because of their extraneous nature.

7. Income from publications, seminars, etc., was considered offset by related costs.

When the accountant submitted his report, he accompanied it with an Estimate of Fixed Costs (EXHIBIT 1), an Estimate of Variable Monthly Costs (EXHIBIT 2) and a Break-even chart (EXHIBIT 3). He offered the following conclusions:

1. Under the conditions assumed above, it is necessary to utilize the full-time staff of 9 operators 76.5% of the time to break even.

2. Sales should be increased through a higher utilization of the present staff rather than through additions to the full-time staff.

EXHIBIT 1

BUSINESS RESEARCH, INC.–ESTIMATE OF FIXED COSTS–1956

	Monthly	Yearly
Salaries and wages:		
Burns, New York	$ 650	$ 7,800
Clark, Receptionist	200	2,400
Nolland, Sales	420	5,040
Peckenpaugh, Accountant	400	4,800
Walker, President	500	6,000
	$2,170	$26,040
Advertising–Chicago	400	4,800
Advertising–New York	100	1,200
Depreciation–Office	20	240

	Monthly	Yearly
General Office Expense–Chicago	$ 166	$ 2,000
General Office Expense–New York	50	600
Postage	40	480
Professional dues, tuition, etc.	20	240
Professional services	50	600
Rent	433	5,200
Travel Expense–Chicago	100	1,200
Travel Expense–New York	166	2,000
	$3,715	$44,600

EXHIBIT 2

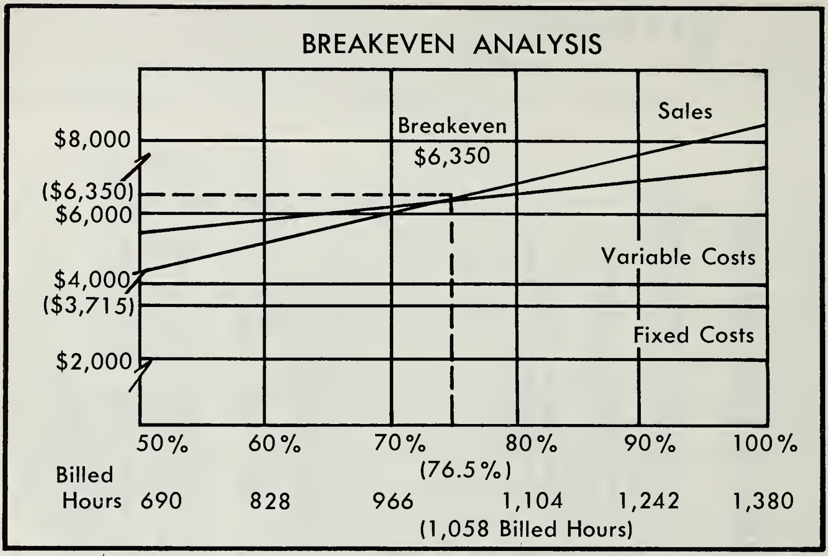
ESTIMATE OF VARIABLE MONTHLY COSTS–1956

(Full-Time Staff of 9 Consultants Assumed)

Per cent capacity used	50	60	70	80	90	100
Hours billed	690	828	966	1,104	1,242	1,380
Salaries:						
9 Operators @ $2.40 hr.	$1,656	$1,987	$2,318	$2,649	$2,980	$3,312
Payroll taxes, etc.	83	99	116	132	149	165
	$1,739	$2,086	$2,434	$2,781	$3,129	$3,477

Remainder of salary of full-time staff included in fixed expense schedule, or against revenues not billed against fixed staff activities.

EXHIBIT 3



3. If peak-load and/or seasonal operators (paid for days worked only) are used for volume in excess of nine-operator capacity, the profits will increase substantially.

4. If more regular operators are added and are used, less than 76.5% of the time the profits will be adversely affected.

However, subsequent review of the books against the stated assumptions of the accountant revealed that not all of them were justified in this situation, although their more obvious features gave them apparent respectability. Also, the failure to state the major assumptions, as already noted, introduced distortions into the analysis. For example, the adherence to existing sales prices and mix, without any appraisal of alternatives, could serve only to buttress the habitual pattern of inflexibility in scheduling staff time. Many other assumptions were, similarly, obstacles to introducing improved practice or even identifying poor practice. A review of prior years' profit and loss statements indicated that, because all but consulting service revenues of the firm were excluded from the breakeven analysis no problem of sales mix arose for the accountant. However, the assumption made should have been presented clearly to the management for consideration in the overall analysis because any assumption may become invalid under changing conditions. The conclusions of the accountant, reported above, could well be amplified as follows:

1. Unless the practice of employing and scheduling the analysts more flexibly is followed, the full-time staff must be assigned 76.5 per cent of available time to break even. If scheduling of periodic analysts can be adapted to regular clients to the extent of another 1,840 hours per year x 76.5 per cent or only about 1,400 hours per year, the break-even point can be reduced $368, or almost 6%, per month from $6,350 by each reduction of one full-time staff member.
2. Sales should be increased by a greater use of temporary staff rather than through additions to full-time staff.
3. Time of work for clients should be shifted as much as possible to off-season schedules.
4. Addition of regular operators should be avoided until capacity is upgraded via improved utilization of temporary consultants.
5. If revenues from seminars and publications are reduced by the implementation of conclusion number one as previously stated (a doubtful situation), the man-hours will, nevertheless, be billed at a profit-making price. However, this is not true of the seminar and publication activities as now carried on.
6. Pricing structure for various types of service should be re-examined and revaluated.

THE 1957 ANALYSIS

Again, early in 1957, the president of Business Research requested a break-even analysis by the accountant. Because demand for consulting services had weakened, she instructed him to use a staff of only seven full-time consultants in his estimates. A change in selling commissions also increased revenues per chargeable hour from $6.025 to $6.10. The accountant examined monthly profits, using the same assumptions as in 1956, except as these were modified by the instructions of the president. The assumed conditions proved to require utilization of the full-time staff of seven operators 100 per cent of the time in order to break even! This impossibility required management action to resolve. The alternatives available included:

1. Reduction of fixed costs (overhead).
2. A higher average utilization of the full-time staff in 1957 than was obtained during 1956.
3. An increase in sales sufficient to warrant an increase in staff size.
4. Increase in selling prices.
5. Reduction of staff salaries.

The one sidedness of the 1956 analysis was thus sharply outlined by the 1957 schedule. The first alternative that overhead had to be reduced, was in direct contradiction to underlying assumptions of what expenses were fixed and what expenses were variable. The second manifests the seriousness of the situation, for the highest possible utilization of full-time staff in 1957 did not cover expenses unless basic management operating policies

were changed. Had a more adequate presentation of these elements been provided the previous year, the dilemma presented by 1957 exhibits might have been avoided.

SOME COUNSEL ON THE PRESENTATION OF BREAK-EVEN ANALYSIS

The accountant must deal with philosophy of operation, for he is the individual who should be in a position to provide the needed blend of training and figures to assist management in these aspects of its operating policy development. Break-even charts are the cost-volume side of the price-volume, cost-volume equation. Internal relationships between components of revenue and expenses must not be ignored to quicken delivery of a report. All assumptions should be reviewed in detail—and realistically. If an assumption is not clearly dependable, it should be given individual comment. Conditions underlying such assumptions should be continuously observed and reported upon when circumstances have weakened them. For example, the assumption in the present case of a full-time staff employment program would become invalid if the management started using a more flexible employment practice.

Whenever a break-even analysis is expressed in terms of percentage of capacity, it would be most helpful to management to include some type of statistical report giving the percentages of capacity utilized in the past. In the situation described here, the accountant did it in his report for the second year after the statistical record needed for accumulating the data had been established. It is important, however, that the break-even analysis and the capacity report be expressed in comparable terms, such as, press hours run, hours of service charged, etc.

If these suggestions are closely followed, fewer break-even analyses are likely to be prepared, but the usefulness of those prepared will be substantially enhanced.

58. SOME OBSERVATIONS ON THE BREAK-EVEN CHART

A. W. Patrick*

The author reviews the break-even assumption and among other things discusses its applications when production does not equal sales during a given period.

* From *The Accounting Review,* XXXIII, 4 (1958), 573-80. Reprinted by permission of the publisher.

A planning tool which has long been at the disposal of accountants and business managers is break-even analysis. Its virtues have been widely disseminated, and occasionally one may encounter some individuals who seem to have as much faith in the power of the break-even chart as did the patrons of the potions sold by the old traveling medicine show. Others have accepted break-even analysis as a useful tool but have been less panegyric in their discourses on the subject.

The several assumptions which underlie the conventional break-even chart are of such a nature as to make imperative the exercise of caution in using it as a basis for decision making. Unless these assumptions are thoroughly understood, its use may lead one to incorrect conclusions.

The conventional break-even point may be determined by solving for R_b in the equation $R_b - V - F = O$, where R_b is break-even revenue, V is total variable cost at break-even sales, F is total fixed cost, and O represents zero profits and losses. In the conventional break-even chart the total cost line at the lower extremity cuts the Y axis at the point where costs are fixed and production and sales are zero. From this point it slopes upward to the right. Revenue is also represented by a linear line which originates at the zero intersection of the Y and X axis and slopes upward to the right; it is often presented as a 45-degree line. The point at which the total revenue line crosses the total cost line is known as the break-even point, and at this level of production and sales the firm allegedly will have neither net income nor net loss.

CHARACTERISTICS OF THE CONVENTIONAL BREAK-EVEN CHART

Some of the assumptions which underlie the conventional break-even analysis for a manufacturing situation are as follows:

1. Costs are either fixed or variable, or at least they can be so classified for purposes of this analysis.
2. Fixed and variable costs are clearly separated.
3. Selling price is constant regardless of the level of output.
4. There is one product, or a constant sales mix if more than one product is involved.
5. Production and sales are equal, and as a result all fixed costs incurred in the period covered by the analysis will be deducted from revenue realized in the same period.

On the basis of the last assumption no consideration is given to the situation where production and sales may not be equal and hence to the possibility that some of the fixed costs may be deferred in inventory, some may be included in cost of sales, and the portion attributable to idle facilities may be charged against revenue as a period loss.

If the assumptions as outlined above are reasonably valid, the analysis may be helpful in making some managerial decisions. On the other hand, the mathematical results of a cost-volume-profit computation can be no

more reliable than the assumptions upon which the computation is based. None of the outlined assumptions may invalidate the usefulness of the analysis in a particular situation. On the other hand, it is conceivable that in another situation they may be such as to cause the results to be misleading. Although all of the assumptions may be questionable, attention in this paper is focused on one: that production and sales are equal, under which condition all fixed costs are charged against revenue in the period in which such costs are incurred.

Break-even analysis is usually thought of as a short-run concept and probably will be found to be more useful in short-run planning than in long-run decision-making, since the forecast of revenues and expenses tends to become more unreliable the longer the period covered in the projection. Professor Neuner writes:

> Break-even analysis and charts must be kept current and not attempt to reflect probable operating circumstances over a period longer than a year because not only the mixture of variable cost and income elements may change but also fixed costs gradually shift over extended periods of time.[1]

It has been suggested that a break-even chart is essentially a picture emphasizing long-run average total costs, but most useful for "short-run" decision-making. The writer is dubious of the usefulness of break-even analysis if a "long-run concept" is attached to it because in the "long run" all factors may change. This would mean then that the older break-even chart would have to be discarded and a more current one prepared. This would appear then to be *prima facie* evidence that break-even analysis must be essentially a "short-run" concept.

A cost-volume-profit analysis is primarily concerned with current or future expenses and revenues and not with past costs deferred in inventories. Neither does it conventionally assume that any current production will remain in inventory, but rather attempts to portray the profit or loss proposition which will result if planned production is manufactured at the projected costs and is sold at the projected sales prices.

Quite clearly, some current production may be sold during the period, and some of it may remain in inventory. In some periods this divergence between production and sales may be of no significance, and this possibility represents the general position taken in discussions of break-even analysis. For example, W. L. Fill has stated that:

> Inventories, though, are usually very small in comparison to total production and, for practical purposes, are ignored in computing sales at various levels of production. . . . The least probable error . . . is obtained by disregarding the inventory problem in determining sales at any volume and to consider all production immediately salable.[2]

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[1] John J. W. Neuner, *Cost Accounting* (Homewood: Richard D. Irwin Company, 1957), p. 790.

[2] W. L. Fill, "Break-Even Chart," *The Accounting Review*, April, 1952, p. 203.

Glenn A. Welsch, although noting that synchronization between production and sales is "frequently of little consequence within any one period," does point out that:

> In case of a lack of synchronization between production and sales it is important that adjustment be made for the increase or decrease in inventory. In this connection it is important that variable factory costs be related to production, whereas selling and administrative variable costs should be related to sales activity.[3]

It is possible for a divergence between production and sales to be of some importance. National income statistics indicate that inventories in the aggregate are at times built up and at other times are reduced. If an inventory does arise out of current production, an appropriate amount of costs incurred must be deferred (not funneled through the income statement until the goods are sold).

DETERMINATION OF PRODUCT COSTS

That only the effective portion of fixed costs[4] are product costs and hence should funnel through the income statement in this form is a widely-held accounting theory. From this follows the proposition that fixed cost of idleness (activity variation loss) is a period charge and should be carried directly to the income statement. This theory is consistent with the theory of normal burden which asserts that the amount of burden attributable to a unit of product at the "normal" volume of activity is the same that is attributable to it at any volume of activity. Break-even analysis, as conventionally presented, makes no provision for the deferral of fixed costs in inventories, since it assumes that production and sales are equal.

Some accountants have advocated a change to an accounting method which would yield results similar to those determined in a break-even analysis. They have argued that fixed costs are time costs and not product costs; therefore, the total of such costs should be charged against revenue in each period. This treatment has been called "direct costing," even though the term is a misnomer.[5] This, of course, is tantamount to saying that the wage of a laborer who operates a lathe in producing goods is a product cost, but that a proportionate part of the cost of the lathe is not a product cost, simply because the cost of the lathe does not vary with the output of the lathe. As Schlatter and Schlatter have put it "the

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[3] Glenn A. Welsch, "Construction and Uses of Break-Even Analysis," *Controller,* October, 1953, p. 465.

[4] The effective portion of fixed costs refers to that portion which has been utilized in producing goods.

[5] "Direct costing" is better described as "variable costing" since under "direct costing," not only would "direct" costs be absorbed into product, but also variable *indirect* manufacturing costs.

exclusion of fixed costs from costs of product is incorrect in theory no matter what arguments of expediency may be advanced for it."[6]

For some internal purposes, it may be useful to prepare an income statement from the "contribution to fixed costs" point of view. But such a treatment cannot be justified on the premise that fixed manufacturing costs are time costs and therefore are not product costs. An attempt to do so must lie in the realm of fancy and not in economic reality.

The theoretical objection to direct costing has not been especially pursued in break-even analysis. Yet, one may reasonably inquire as to the meaning of "break-even" if it does not imply that revenues equal expenses incurred in realizing revenues at an activity level described as break-even volume. If production is more or less than sales and if all fixed costs are charged against revenue each period, as may be implied in the conventional break-even analysis, expenses will not be properly matched against revenues.

CURRENT EXPENSES AND BREAK-EVEN CONDITIONS

Since the analysis will probably be more useful if it reflects only current or future expenses and current or future revenues, let us examine, with the aid of the following data, the break-even point without regard for beginning inventories (past costs):

Burden Budget

Practical Capacity = 10,000 direct labor hours or 1,000 units of product

	Total	*Rate*
Fixed Costs	$30,000	$3
Variable Costs	20,000	2
	$50,000	$5

Current Manufacturing Costs (per unit of product)

Material and Direct Labor	$100
Burden—10 hours @ $5	50
	$150

Selling and Other Expenses

Fixed	$9,000
Variable	$15 per unit sold
Selling Price per Unit	$200

From these data, break-even sales will be found to be 600 units determined by the conventional method with use of the formula: $PQ_b - V_xQ_b = F$, where P is the sales price per unit, Q_b the break-even sales units,

[6] Charles F. Schlatter and William J. Schlatter, *Cost Accounting* (New York: John Wiley & Sons, Inc., 1957), p. 473.

V_x the variable cost per unit, and F the total fixed costs. When known substitutions are made the equation becomes $\$200\ Q_b - \$135\ Q_b = \$39{,}000$.

The implication of this result is that only at a production and sales level of 600 units will the firm's expenses and revenues be equal. Conceivably, there may also be an implication that a profit may be realized if production exceeds 600 units or that a loss may be realized if sales are less than 600 units.

These implications are not borne out, however, under accepted theories of income determination. An output of 950 units with sales of 300 units will also yield no profit and no loss as is demonstrated below:

Sales (300 units @ \$200)			\$60,000
Less: Cost of Sales (300 units @ \$150)		\$45,000	
Selling and Other Expenses:			
Fixed	\$9,000		
Variable (300 units @ \$15)	4,500	13,500	58,500
Operating Income			\$1,500
Less: Activity Variation Loss (50 units @ \$30)			1,500
Net Income (Loss)			-0-

As a matter of fact, there are numerous combinations of sales and production which will yield no profit or loss. Thus, instead of there being only *one* break-even point, there is in reality a break-even line. This condition is illustrated in Chart 1. Line *GBH* is the break-even line and any combination of sales and production along this line is a break-even combination.

The break-even line will always run through the conventional break-even point. This line will also cross line *IC* (maximum production vertical) where the gross margin is sufficient to cover the selling and other expenses, since at maximum production there will be no activity variation loss.

Point *H* can be determined by the formula:

(1) $NP - CN - S_vN - S_f = 0$, when
- N equals number of sales units
- P equals sales price per unit
- C equals manufacturing cost per unit of current production
- S_v equals variable cost of selling and administrative expenses per unit of sales
- S_f equals fixed selling and administrative expenses.

When known substitutions are made, equation (1) will appear as follows:

$$\$200N - \$150N - \$15N - \$9{,}000 = 0,$$

and when solved, $N = 257$ units (rounded).

Since *GBH* is a straight line and since points *B* and *H* have been computed, it is easy to extend line *BH* upward, thus establishing point *G;* therefore, there is no need to compute this point mathematically. It might be noted, however, that if this line were extended to cross the zero production vertical, it would intersect the latter at the point where:

Units sold × (unit sales price—"normal" manufacturing cost per unit) equals total fixed manufacturing costs + other fixed expenses treated as period charges.

Line *GB* will probably be of little or no use since any combination of sales and production along line *GB* implies a beginning inventory, i.e., sales exceed production along this line. Line *ABC* is the revenue line in a conventional break-even chart, but in Chart 1 it serves to show the maximum sales potential this period out of current production. The triangular area *AJC* is therefore of no significance in appraising the results of this period's activities under the assumption that there is no beginning inventory. Any combination of sales and production falling within the area *ABHI,* but not on line *BH,* will yield a net loss; whereas, any combination of sales and production falling within the area *BCH,* above line *BH,* will yield a net profit.

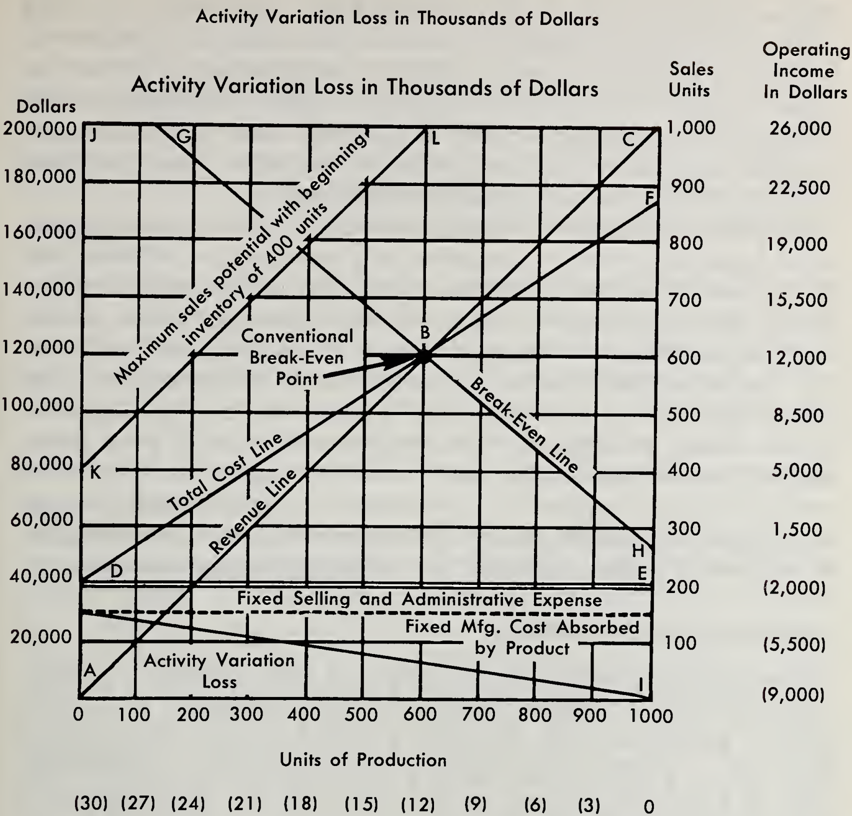
It is possible to determine from the chart the estimated profit or loss at any combination of sales and production. To accomplish this, the income or loss realized before subtracting the activity variation loss (for brevity, referred to hereafter as operating income) should be inserted on the *Y* (vertical) axis at the various levels of sales. In addition, the activity variation loss should be inserted on the *X* (horizontal) axis at the appropriate levels of production. To estimate the profit or loss, the activity variation loss at the given production level should be subtracted from the operating income at the given sales volume. Thus at an expected sales volume of 600 units, the operating income to be realized is $12,000 determined as follows:

Sales (600 units @ $200)			$120,000
Less: Cost of Sales (600 units @ $150)		$90,000	
Selling, Administrative and Other Expenses:			
Fixed	$9,000		
Variable (600 units @ $15)	9,000	18,000	108,000
			$ 12,000

At a production volume of 800 units the activity variation loss would be $6,000 computed as follows: 200 units @ $30.

Therefore, at a sales volume of 600 units and production level of 800 units, a net income of $6,000 is expected ($12,000 less $6,000).

CHART I. BREAK-EVEN CHART.



Implicit in the above discussion is a suggestion that the conventional break-even analysis is a special case of the more general one. The break-even point usually computed is a valid one under its restricted assumptions. The assumptions, however, are not necessarily valid, and when they are extended to recognize that (1) at times current production may exceed sales out of that production and (2) only the effective portion of fixed costs are assigned to product, *the* break-even point is found to be only one such point among many.

PAST COSTS DEFERRED IN INVENTORIES

Up to this point, the discussion has dealt only with current or future costs. Past costs deferred in inventory have not been considered. It, therefore, should be obvious that the results of operations for the current

period as reflected by the accounting records will not necessarily agree with those indicated by the break-even analysis to the extent that beginning inventories (carried at costs different from current costs) were sold during the period. If beginning inventories are taken into account, the figures will probably be more useful for decision-making if they are priced at current costs. Line *KL* on Chart 1 reflects the maximum sales potential if the beginning inventory is 400 units. Thus, with this assumption sales could exceed current production and under these conditions line *MBH* becomes the meaningful break-even line.

It is possible to construct a break-even chart to reflect current expensing of beginning inventory costs when such unit costs are different from the unit cost of current production. Again, there will be many combinations of sales and production which will yield neither net income nor net loss. This condition will be represented by a discontinuous break-even line. The discontinuity will be registered under a *FIFO* assumption at the point where the break-even line crosses the horizontal sales line representing the amount of beginning inventory, since it is at this point that a change in relationship between cost of sales and sales occurs. This break-even line may be computed by determining the pertinent points through use of algebraic equations, and it may be computed under any assumption of cost flow as well as of activity used in establishing the burden rate.

SOME CONCLUDING REMARKS

It has been the objective of this analysis to focus attention on restrictions of one of the assumptions underlying the computation of the conventional break-even point. The chart presented purports to be nothing more than a graphic presentation of cost-volume-profit relationships. With the given sales price and the given cost structure, the net income or net loss to be realized at any combination of sales and production may be read from it when income is determined in accordance with sound accounting theory.

The above discussion does not include any assumption concerning a price at which the final inventory may be sold. It is, of course, possible to make assumptions based upon detailed studies. But it should be recognized that such assumptions necessitate extending the analysis beyond the current accounting period. Such an extension may be valid if all the pertinent factors are considered sufficiently reliable for decision-making. If the sales maximum in the current year were 500 units, the *future* market, among other factors, should be studied carefully before reaching a conclusion to produce at any level, much less at the conventional break-even level of 600 units.

It is doubtful, even when the break-even point *per se* may be used in decision-making, if it is the best approach to a problem. A firm does not desire to realize zero profits, but rather it is interested in knowing the

probable profit or loss of alternative courses of action and whether or not that profit is sufficient to provide the required rate of return. It is suggested, therefore, that a knowledge of differences in profit may serve management better than a knowledge of differences in break-even points.

Presumably, management is constantly striving to maximize its net income or minimize its net losses (perhaps sometimes in the short run, perhaps sometimes in the long run). If a knowledge of the break-even point is a prerequisite to management's efforts to "squeeze" costs, then management would seem to lack an understanding of its responsibility. It should be trying to maximize the return on investment regardless of the break-even volume.

It is, therefore, concluded that less emphasis should be placed on the specific break-even point and that attention should be focused on the probable profit or loss results of alternative courses of action. Break-even points are not necessary in arriving at intelligent decisions which involve cost-volume-profit relationships. Break-even points do exist; and for this reason, it may be of academic interest to know what they are. But if they can be used, it is suggested that there is almost invariably a better approach to the problem.

Occasionally, management may wish to make use of a day-by-day reference point in appraising quickly actual results of operations relative to planned results. For this purpose, the break-even point has sometimes been advocated. In this connection, it is suggested that a more significant reference point is the one planned, rather than the one at which the firm purports to break even, unless the break-even point is the planned point. If sales, for example, are greater than planned sales, assuming the planned cost structure, management may regard this as "good" but if sales are less than planned sales, this may signal a review of the situation. On the other hand, a knowledge of the fact that sales were more or less than the conventional break-even sales, if the conventional break-even sales are not the planned sales, is not nearly as meaningful as is the knowledge that actual sales deviated from planned sales and in what direction they deviated.

If a "point" is considered important to management in its study of operations, it is contended that a "satisfactory point" is the significant one and not the break-even point as such. If the break-even point is important, it is because management considers that operations at no loss is satisfactory for the time in question. The break-even point at a particular time may be a "satisfactory" one, but in the course of events other points will more often be the "satisfactory" ones. It is concluded, therefore, that in emphasizing an operating point for decision-making, the point receiving such emphasis should be a "satisfactory" one when all pertinent factors are considered.

It is hoped that the chart as presented above may help integrate the results obtained from a conventional break-even chart with those obtained

when production and sales diverge. Break-even charts should be accompanied with detailed budgets and used with considerable caution only when the assumptions underlying the charts are thoroughly understood.

Of more importance, however, is the placing of emphasis in planning on the relative profitability of alternative courses of action rather than on the break-even point. Neophytes should not be led into thinking that the break-even point is the best approach to a problem if it cannot be so demonstrated. Should one set about to compute a break-even point, he should recognize whether or not a knowledge of the point is pertinent to a decision faced by management and if it is pertinent, in what way.

59. VARIABLE BUDGETING FOR PLANNING AND CONTROL

S. Alden Pendleton*

The author discusses the ingredients entering into a profit goal stressing, as he does, the manufacturing cost element which is one of the factors playing an important part in the attainment of the goal. A system of performance reports is also described.

There are measures which, when adopted in time, will not only reduce the acute effects of lower volume but will also help with the everyday planning of your business, and serve as a tool to permit more effective management with reduced effort. These steps include the following:

1. Establishment of a profit goal.
2. Development of volume and price objectives.
3. Determination of cost objectives.
4. Control of expenses within the limits set by these objectives.

ESTABLISHING THE PROFIT GOAL AND THE SUBORDINATE OBJECTIVES

In the past, your company's profit objective may have been determined by historic patterns, or by the need for retained earnings in the business or by the sales department's idea of what prices the market will bear. But are profit amounts to cover these needs enough? Do you have an adequate profit objective?

One advantage of developing and using a profit plan, is that future decisions concerning the addition of products or facilities, or the making of

* From *National Association of Cost Accountants Bulletin*, XXXVI, 3 (1954), 323-34. Reprinted by permission of the National Association of Accountants.

other expenditures, may be based on the effect of such moves upon return on net worth. If a new project does not measure up to the objective set with respect to return on net worth, it should be side-tracked in favor of one which does. If a number of projects are under consideration, analysis of each on this basis will aid materially in the proper selection.

The profit goal may be expressed in terms other than return on net worth. From the standpoint of a general manager of a decentralized division, return on total assets employed would be a more useful measure. Whether the asset is financed through net worth, bank loans, or accounts payable is of little concern to him. If his performance is to be measured against that of another manager, then return on the total assets entrusted to his care becomes the important consideration.

Once the profit goal is established, the most expeditious way of achieving it must be determined. This requires knowledge of your product's position in the market, its long-run sales expectancy, and the price at which that sales volume can be realized. Analysis should also be made of underlying trends affecting the future of your market, including such factors as population growth, national income, consumer buying habits, and the possibility of improving your market penetration. With such background information, you should be in a position to make logical long-range forecasts upon which your pricing policies and cost control programs will be based.

There are a number of ways to arrive at cost objectives. For the long run, perhaps the most simple is to subtract the profit objective from estimated sales. This, however, leaves all the unknowns in the cost area. To have attainable cost objectives, they must be built from the ground up. Then, if the elements of sales and cost do not yield the desired profit, attention can be directed towards any one of several solutions, with the knowledge that cost yardsticks are adequate for measuring short-term performance and that any performance failure will be flagged quickly.

Profit improvement projects could include cost reduction, product simplification, volume increase, new products, price adjustment, or even administrative changes as sweeping as decentralization or integration. By these or other measures, the company's over-all program may be aimed towards attainment of the profit objective.

CONTROL OF EXPENDITURES—THAT'S WHERE THE BUDGET COMES IN

Knowledge of the costs incurred in making your various products is essential to their control. The direct material cost for each product should be available from bills of material, while direct labor should be obtainable from labor bills or, in their absence, from historical records or time studies and estimates. Overhead poses a more difficult problem because of the

effect on unit cost of varying volume. An inflexible overhead budget based on forecast volume is frequently invalidated by unexpected sales or by the more serious business down-turn in the early months of the year. If such budgets are changed arbitrarily, performance cannot readily be compared from one period to another.

The best answer to such a predicament is the use of a variable budget. Although all expenses vary, some fluctuate directly with productive labor, while others remain relatively constant regardless of the productive labor level. Between these two extremes lies many expenses which vary but not in direct proportion to direct labor. Rearrangement is an example. To create a budget which will accurately authorize all such expenses is a difficult task.

Such a budget may be approximated, however, by making logical assumptions as to the portion of each expense account which varies directly with direct labor or other chosen measure of volume, and assuming that the balance is fixed. This determination should be made at a predetermined average volume level. Several automotive companies base their budgets on standard volume, which is defined as the average volume expected over the future period of about ten years. Although you may wish to select a shorter period, particularly if in a growing company, the longer periods have the advantage of eliminating the effects of cyclical variations from both budgeting and pricing.

A variable budget is one which segregates the fixed from the variable expense, under the assumption that the latter will vary directly with manufacturing volume as reflected by the productive labor level and that the "fixed" expense will remain constant within reasonable limits of volume fluctuation. Fixed expense, at least for our purposes here, is that expense or portion of an expense which will not change during the year under study *solely* due to changes in manufacturing volume.

Once the variable budget is established, it can be expressed in terms of fixed and variable authorization, separately, and repeated revisions become unnecessary. Performance reporting is facilitated, and the plant manager is relieved of the pressure of relatively uncontrollable fixed expense on the down-swing, while at the same time restrained from overspending during prosperous times. Further, performance against budget can be compared from one period to another.

ASSEMBLING THE DATA; SEPARATING FIXED AND VARIABLE EXPENSE

The manufacturing expense budget may be prepared in detail for a list of accounts like those in EXHIBIT I and should be built at the average sales

volume contemplated for the coming year. Actual expenses for the current year to date should be entered in the first column and the best present estimate for the full year in the second column. Any adjustments to the year-to-date expenditure level to bring the year's total in line with that expected next year should be included in Columns 3 through 9, in line with their headings or in blank columns if others are needed. Amounts shown in the adjustment columns should be fully explained. Labor rates

EXHIBIT I

PREPARATION SHEET FOR MANUFACTURING EXPENSE BUDGET

Division ____________ Year ________

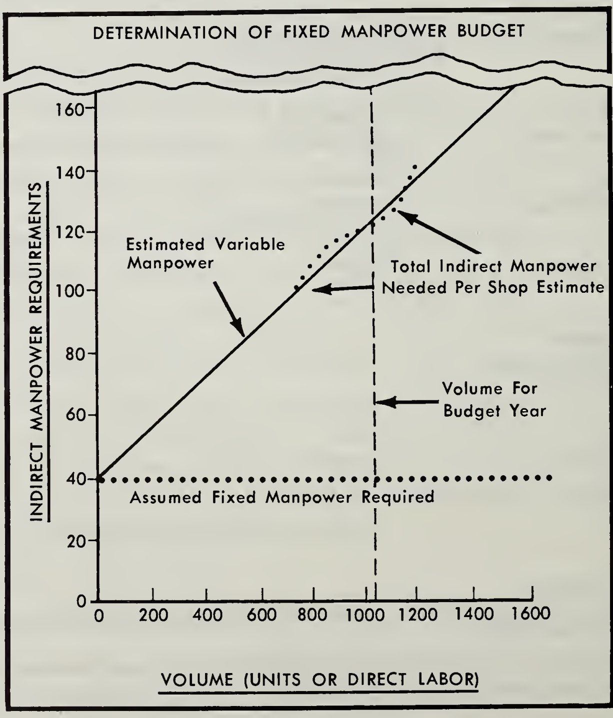
Account*		10. Proposed budget Total	11. Proposed budget Fixed	12. Proposed budget Variable	13. Variable % to standard direct labor
Direct Labor					
Gross direct labor	The following are the headings of Columns 1 to 9 in the schedules as used:				
Transfers	1. Year to date				
Net direct labor	2. Estimated full year				
Standard direct labor	3. Wage rates				
Indirect Labor	4. Pensions				
Gross indirect labor	5. Indirect materials				
Transfers	6. Efficiency				
Net indirect labor	7. Volume				
Other Overhead	8. 9. Misc.				
Employee benefits					
Payroll taxes & insurance					
Operating supplies					
Tools					
Utilities					
Maintenance					
Losses and errors					
Fixed charges					
Depreciation					
Other expense					
Transfers					
Total other overhead					
Net manufacturing expense					

* Detail by sub-accounts

and direct material prices should be included in the budget at the levels currently being experienced.

After entering total budget expense for next year in Column 10, that portion which will not vary if volume should increase or decrease over a significant range should be shown in Column 11. One method of determining fixed expense is to plot indirect manpower and material requirements furnished by shop supervision over a reasonable production volume range (for example, 35 per cent above to 35 per cent below the budgeted volume) on a graph of expense (or manpower) against budgeted volume (0 to 135 per cent), and fit a line through the reported requirements back to zero volume. This line should intersect the left side of the graph at approximately the fixed expense level included in the estimates, as shown by EXHIBIT 2. The fixed amount thus determined should not be greater than the lowest amount management would authorize to sustain production on a going concern basis. Another means

EXHIBIT 2

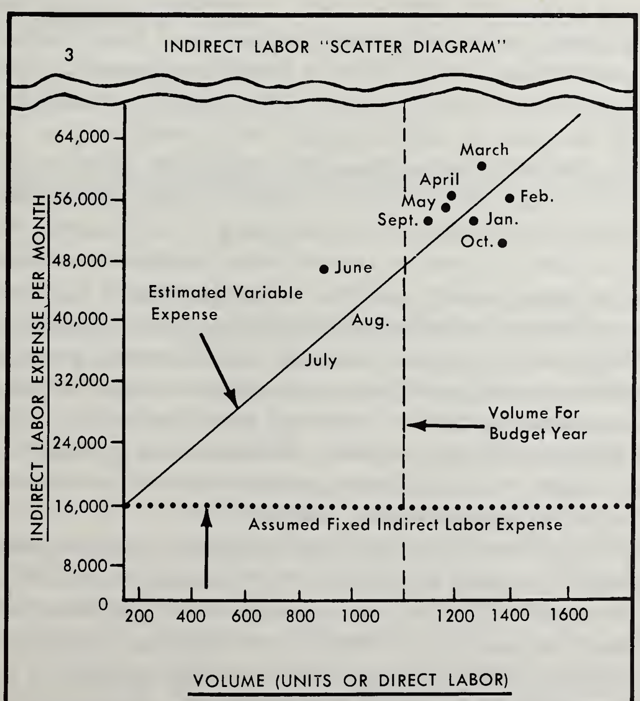


of determining fixed expense is to plot the amount incurred for a particular account monthly over a period of time, with expense on one axis and an appropriate measure of production volume along the other axis. The "scatter diagram" which results should show whether there is any pattern of increasing or decreasing expense with volume, and the line fitted to such a scatter diagram may be carried back to zero volume to determine fixed expense, as illustrated by EXHIBIT 3.

After arriving at the fixed content of each account, the variable amount may be determined by deducting the fixed portion from the total amount budgeted and entering the result in Column 12 of EXHIBIT 1. The variable ratio to standard direct labor for each account is then calculated by dividing Column 12 by the total amount of standard direct labor expected for the year, and entering the result in Column 13.

The manufacturing expense budget by month is determined by adding one-twelfth of the fixed budget for the year to the variable budget for

EXHIBIT 3



each month. The monthly variable budget is determined by multiplying the month's expected standard direct labor produced by the variable ratios from Column 13 of EXHIBIT 1. Amounts calculated in this way may be used in monthly expense forecasts. The budget figures used for performance reporting would be calculated in the same manner, using actual standard direct labor produced as a base.

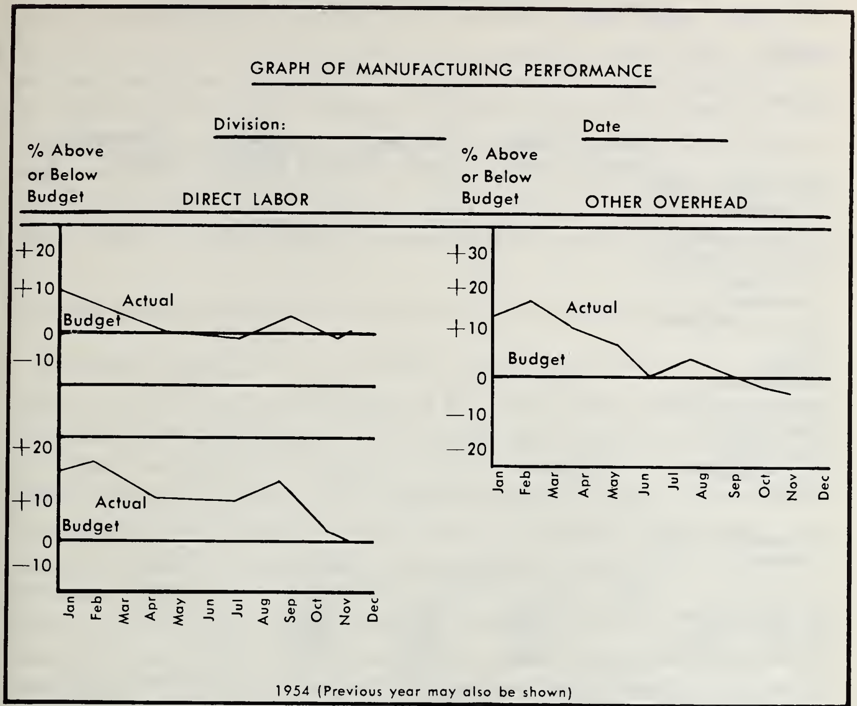
The proposed budget should be reviewed carefully, and compared with current expenses and the present budget. Every effort should be made to improve the standard of performance each year. One technique is to establish new budgets at the best expense levels attained over reasonable periods in prior years, thus constantly increasing the task of meeting the objective. In the early years of a new budget program, this could be carried so far as to tighten each budgeted expense by an arbitrary five or ten per cent each year. In doing this, the budget for expenses not controllable by the plant manager should either be increased or decreased realistically, or be separately budgeted and reported.

REPORTING PERFORMANCE AGAINST THE BUDGET

After the budget has been accepted, a simplified reporting procedure must be adopted, which will permit preparation of trend charts for each account classification, or for those in which management is most interested. The zero line of such a chart might represent on-budget performance, with the ratio of actual expense each month over or under the budget then plotted above or below the budget line, as shown by EXHIBIT 4. Such a chart may also be used to show the trend of net direct labor versus standard direct labor at the beginning of the budget year as the base line, and also the trend of current labor standards as compared with the base line thus focusing attention on improvements in standards. An advantage of this presentation is its simplicity, and the ease with which a trend change can be spotted. Also, the manufacturing performance of each plant thus may be graphically presented on a single sheet of paper. A sample manufacturing expense reporting procedure useful in connection with the budget procedure outlined, and which will provide the data for such trend charts is outlined below, and may be embodied in a monthly manufacturing report as shown on EXHIBIT 5.

In preparing the monthly performance report, actual expenses for the month should be entered in Column 1 of the exhibited report form. One-twelfth of the annual fixed expense included in the manufacturing expense budget should be entered in Column 2. Although some elements of fixed expense will vary with the season, such as utilities and heat, it is assumed that these variances are relatively minor. So, for convenience, the same

EXHIBIT 4



amount of fixed expense should be included in the budget each month. Actual variable expense, Column 3, is determined by subtracting budgeted fixed expense from total actual expense. Fixed expense will not change from month to month if properly accrued; therefore, any deviations in fixed expense are thrown into the actual variable column and excesses must be offset by actual variable reductions elsewhere. The variable budget, Column 4, is determined by multiplying the month's standard direct labor by the budgeted variable ratio to standard direct labor for the account, obtaining this figure from the annual manufacturing expense budget. The total budget is the sum of the fixed expense (Column 2) and the monthly variable amount (Column 4). From this budget, total actual expense in Column 1 should be subtracted to arrive at the variance in Column 6. Variances will be enclosed by parentheses when the actual expense is greater than the budgeted amount. The variance percentage

EXHIBIT 5

MANUFACTURING PERFORMANCE REPORT*

Division ________

Month ________

	1 Total actual	2 Fixed budget	3 Variable Actual	4 Variable Budget	5 Total Budget	6 Variance Amount	7 Variance %
Gross indirect labor							
Transfers							
Net indirect labor							
Employee benefits							
Payroll taxes and insurance							
Operating supplies							
Tools							
Utilities							
Maintenance							
Losses and errors							
Fixed charges							
Depreciation							
Other expense							
Transfers							
Net manufacturing expense							
Net direct labor		XXX	XXX	XXX			
Std. direct labor		XXX	XXX	XXX			
% Net to Std. D.L.		XXX	XXX	XXX			

* Report in actual use also has figures for the year to date.

should be calculated to one decimal place by dividing the variance by the total budget amount.

Year-to-date actual and budget amounts in columns on the lower half of the form (omitted from the exhibit) should be calculated by adding the amounts for the month to the year-to-date amounts for the previous month. These totals must always add forward. Therefore any year-to-date adjustments must be included in the figures for the month as well as in the year-to-date figures. The variances and variance percentages should be calculated as has been described. The variable percentages to standard direct labor for both the month and the year-to-date should be entered in the final columns of the lower section. These should be calculated to one decimal place by dividing the actual variable expense by the period's standard direct labor. The year-to-date actual variable expense may be calculated by adding up the monthly amounts shown in Column 3 of current and prior reports.

Net direct labor should be entered at the bottom of Column 1. Standard direct labor for the period may be determined by multiplying the period's total production, including only the production value added during the period as determined by production counts at various inspection points, by the standard hours allowed for the operations performed. Where standard hours are not in use throughout the plant, some approximation of efficient direct labor utilization should be made for each job, on a consistent basis, and added to the standard total. The direct labor standard hours should be multiplied by the average departmental rates to determine the standard direct labor to be entered on the form. Percentages of net direct labor to standard should be entered in the spaces provided.

THE OFFENSE—FORECASTING; DEFENSE—THE BREAK-EVEN CHART

Invaluable adjuncts to the monthly performance reports are forecast reports, which may be established on the same basis to permit a current look at the immediate future. The forecast reflects latest costs and prices, schedules, and probable changes, to make it possible for management to detect unfavorable trends far enough in advance to take action to minimize their effects. To do this, each month a forecast of the coming four months is prepared in summary form, based on the current production schedule. From this schedule, the required direct labor is determined, along with the amount of indirect labor which would be in line with the budget at that volume level. Through this means, employment and other expenses may be adjusted to the budgeted level before the first day of the period being forecast (rather than six weeks or more later), performance can be closely tied to the goal which has been established, and any departures from that expense level will be quickly flagged. Another technique which may be used to good effect is the comparison of both budgets and actual performance, by account, among similar plants, or the comparison of similar operations or functions in dissimilar plants. This method will disclose the best performance in the company, which can be used as a target.

This article has concerned itself primarily with manufacturing expense budgets, because this is the area most susceptible to control in line with short-term production and sales requirements. The areas of sales, engineering, and administrative expenses are less subject to variable control than to management edict, but must be watched, nonetheless. Budgeting in the latter areas may follow the "appropriation" form, in which programs are planned for definite periods in advance, based on over-all company objectives. Once the level of activity is committed, the budget normally continues in effect through the end of the commitment period, unless

urgent additional requirements arise, or the economic climate changes appreciably. One method of controlling such appropriation-type budget levels is through the use of project estimates and approvals to support total appropriations requested periodically from management.

If the budget is realistic and ties into the profit goal, and if the operations are planned in advance each month so that the expenses are limited to those justified by the volume of production, the company will be well on the way towards accomplishment of its profit objective. However, because of the effect of relatively fixed appropriation-type expenses, and other expenses in the manufacturing area also relatively fixed, it follows that the company will not have a constant margin of profit, month after month, even if performance does equal the variable budget goal. That fact must be recognized and an average profit goal accepted in its place.

60. GRAPHIC PRESENTATION OF RESULTS UNDER A VARIABLE BUDGET CONTROL SYSTEM

Marjorie M. Osborn*

The author gives a series of charts plus explanation of data used in connection with a budget control system for variable expenses.

Properly set up, accepted and agreed upon by those appointed to assume responsibility for control and supported by top management, a budget control program is a means by which a profit can be realized from holding variable manufacturing expenses in line. In order for a control system to remain dynamic, it is extremely important that top management give it full and enthusiastic support and cooperation—not only immediately after the initial installation but also later when the program is well under way. At the same time, management must receive pertinent, timely and brief, but factual, information regarding the progress of different manufacturing units toward meeting their standards. The best method is

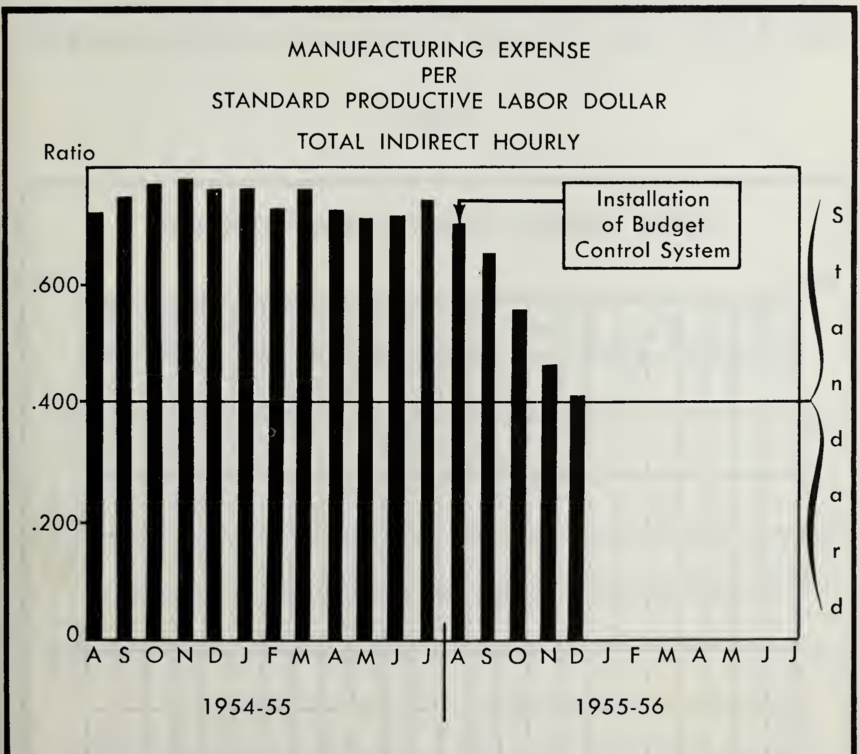
* From *National Association of Cost Accountants Bulletin,* XXXVIII, 4 (1956), 520-25. Reprinted by permission of the National Association of Accountants.

to provide this information through periodic reports and graphic presentation of data.

"SETTING UP" FOR BUDGETING

For the purpose of illustration, we will assume a budget control system has recently been established. A control committee was appointed to fix responsibility in the various manufacturing units and to act as an over-all control by analyzing the cause of variance and determining the course of action. A master budget plan was worked out, points of control established and standards set. The next step was to develop periodical analysis reports and set up a graphic series of analytical charts to show variances

EXHIBIT I

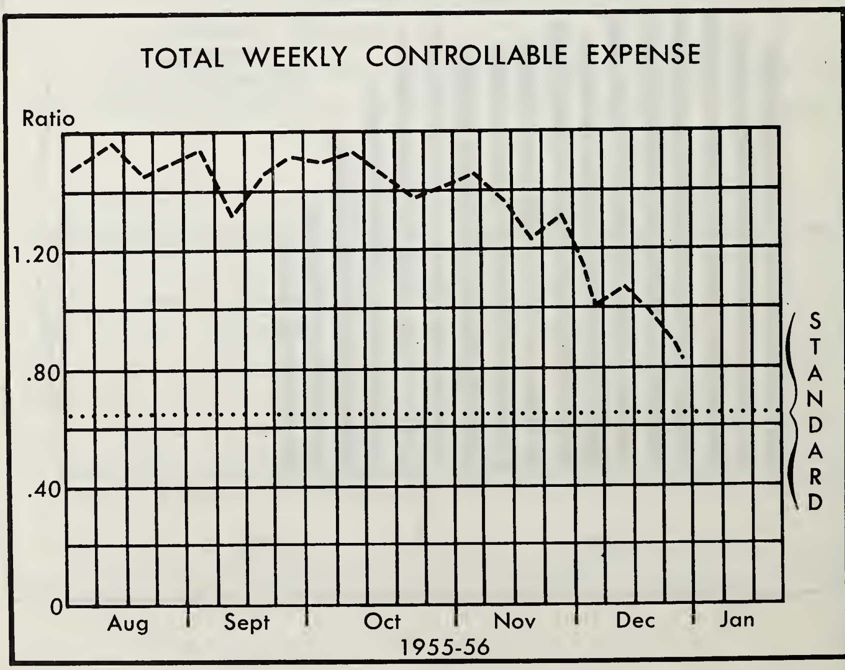


and the progress toward meeting the standards. Once the total division budget had been worked out, the points of control established by cost center and the data defined for each point of control, the master budget was broken down into standard allowances for the controllable expenses in each. To initiate the phase of establishing and controlling the variable manufacturing expenses on a monthly basis, a series of charts were prepared for use in the chart room. A chart was made for each of the manufacturing expense groups plus a detailed breakdown of the indirect hourly expense. These charts (EXHIBIT 1) picked up historical costs for the past year and were designed to show the costs for the current year in order to give a basis of comparison.

WEEKLY REPORTS TO MANAGEMENT

A weekly staff meeting was then scheduled with the control committee. Generally speaking, the following personnel was represented on this committee: division manager, assistant division manager, chief engineer, sales manager, division controller, plant managers and production managers. A report called the weekly cost center data sheet is prepared for

EXHIBIT 2



the committee each week which is an analysis of the difference between the actual and the standard ratio of manufacturing expenses to standard productive labor. This report is submitted to the manufacturing personnel at the staff meeting and they, in turn, review the report with the cost center managers in subsequent meetings.

The variances from standards are noted at these meetings and it is the responsibility of the control committee to investigate the reasons for the variances and see that action is taken to correct them. An explanation of the variance and the corrective action that has been taken is reported at the following meeting. It is at this point that a company is likely to realize that the by-products of a budget control system are often as important as the system itself. A system of this sort often initiates creative planning on a statistical basis and the habit of planning forward instead of looking backward.

In order to condense the data presentation, a series of charts was made up for the use of the division manager and the controller so that over-all trends might be visualized. This weekly series consist of a chart showing the Total Weekly Controllable Expenses (EXHIBIT 2) (in ratio to standard productive labor), Supporting Charts (EXHIBIT 3) showing in detail the

EXHIBIT 3

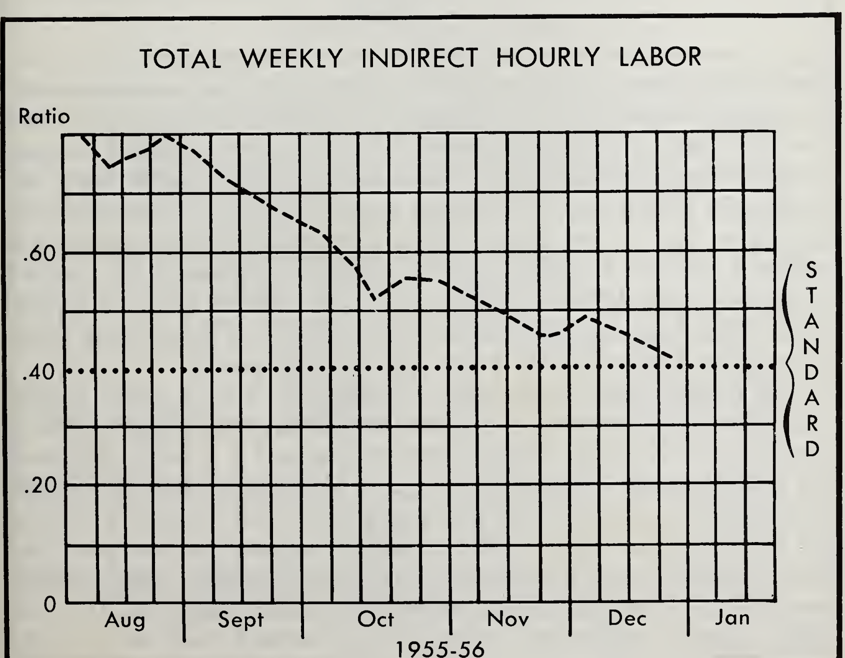
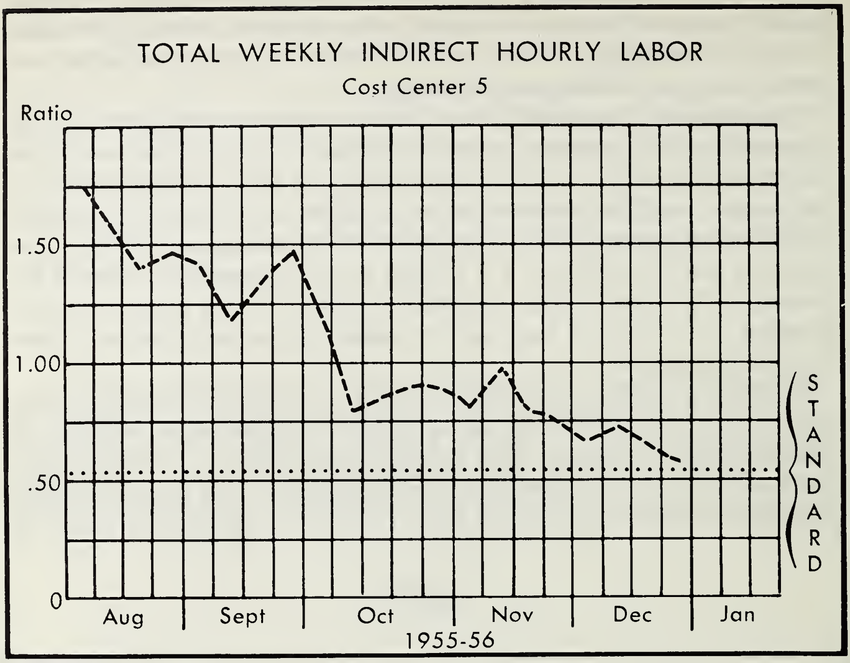


EXHIBIT 4



ratio to standard productive labor for four of the expense groups (indirect hourly labor, scrapped product, indirect material and maintenance and repair) making up the total weekly controllable expense, and a chart for each of the cost centers (EXHIBIT 4). The information plotted on these charts is taken from the weekly cost center data sheet. Graph paper was utilized for these charts so that they might be kept in a notebook with data sheets. For use in the chart room, a second series of bar graphs was prepared (like the monthly series of manufacturing expense per standard productive labor dollar in EXHIBIT 1) showing control data on a weekly basis. These were also plotted from the weekly cost center data sheets showing the standard and the actual ratio of total expense.

This graphic presentation enables management and the entire control committee, which meet weekly in the chart room, to get a quicker indication of trends either upward or downward, as well as a visual picture of the manufacturing expense. Here another by-product enters the budget control picture in that the people responsible for the control of each of the cost centers take great pride in seeing the expense for their particular cost center come nearer to standard each week. Naturally, when management discusses these charts with them during each meeting and they are called upon to explain any variation from standard, they are going to

make every effort to see that their particular realm of responsibility makes a good showing.

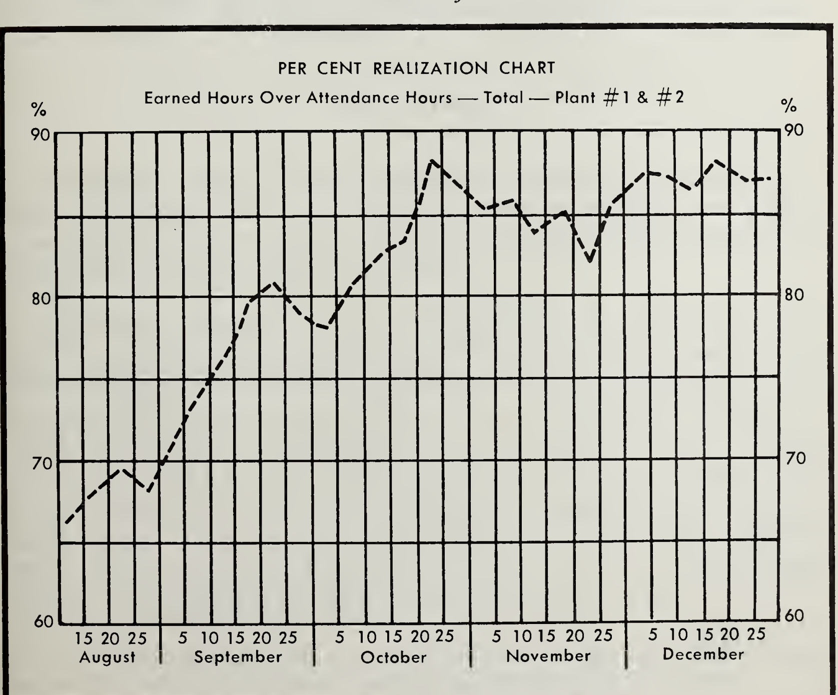
Each cost center manager maintains a weekly chart in his office for each of the variable expenses, showing the standard and the actual ratio of expense to standard productive labor. The cost center manager is responsible for posting this chart each week when he receives his copy of the weekly cost center data sheet.

DAILY GRAPHIC PRESENTATION OF CONTROL INFORMATION

Finally, we were able to work the control system down from a monthly and weekly control of hourly labor to a daily control basis. This was accomplished in a Realization Per Cent Chart (EXHIBIT 5), in order to get an even tighter control and evaluation of operations. The realization ratio is arrived at by dividing earned hours (pay standard times pieces produced) by attendance hours (actual clock hours of direct labor and indirect labor).

An upward trend of the realization ratio reflects an increase in earned hours or a decrease in attendance hours or both. As soon as a downward

EXHIBIT 5



trend shows up on a chart, it indicates that there is a possible lack of work which has not been met by a decrease in the direct labor. This Realization Per Cent Chart is used not only in the management chart room but also in the offices of the plant manager, in order that the first indication that a cost center is out of control will initiate a corrective action.

XVI

ADMINISTRATIVE CONTROL AND THE ACCOUNTANT

61. THE ACCOUNTANT'S BUSINESS WITH BUSINESS FORECASTING

Henry J. Engler*

The author reviews the role of internal and external forecasting in planning, and suggests that the accountant assume responsibility for external forecasting for the enterprise in addition to the internal forecasting with which he has been traditionally identified.

The planning function has, historically, received the minor share of attention in business. Probably this stems from two reasons: a lack of suitable technique for formalizing planning and of usable data which could be employed. Whether these or other reasons account for it, the fact remains that planning is the weakest of the management functions. It seems to me that a good portion of the difficulty in planning has arisen from a misconception of the term. Too frequently, planning is considered a single process. This is no more correct than to consider golf as one skill. The golfer knows that the game is broken up into particular shots, strokes, and approaches, the total of which is the game of golf.

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DECISION-MAKING INVOLVES FORECASTING

This analogy holds true for planning. More correctly, it is the decision-making process and consists of a number of individual processes which include:

1. Research into and observation of factual data, i.e., examination of records, reports etc., in quantitative terms.
2. Research into and observation of qualitative factors, i.e., determination of influences such as weather, politics, etc.
3. An analysis of these data and factors, i.e., breaking them up into those items which affect the business or the particular problem.
4. An evaluation of these data and factors, i.e., determination of their effect on the business or the particular problem.
5. The determination of several alternative courses of action based on the foregoing determination.
6. The evaluation of the advantages and disadvantages of these alternative courses of action.
7. The selection of the best course of action to follow.
8. The determination of the timing and procedure to be employed in following this course of action.

This, then, is the planning or decision-making process. It has been neglected because it is difficult to follow and is contrary to developed habits. We have done a certain thing under a certain set of conditions and results were satisfactory. Therefore, we will do the same thing when similar conditions arise. The only thing wrong with this line of reasoning is that we too often look back and see that we did not attain desired results because what we thought were minor factors proved to be the major ones.

It can be agreed that decision-making for the general policies and operations of a business are the prime responsibility of the executives of the business, the president, vice presidents, general manager, or whatever the titles may be. At the same time, today's businesses are so complex and the business world, itself, is so complex that no executive can discharge the planning responsibility alone. Each man responsible for a specific function—the head of accounting, the personnel manager, the purchasing agent, the sales manager, etc.—must participate in the decision-making process. Here our particular concern is with the accountant. What is his responsibility in the decision-making process?

The decision-making process involves action which must be taken in the future. The fourth step in the decision-making process, given above, is the evaluation of factual data and qualitative factors and the determination of their effect on the business or the particular problem. This is business forecasting. A forecast is a prediction or estimate of any future event or situation. And there is no escape from the forecasting responsibility. It is not a question of whether your company makes business forecasts

but of how it makes them. As soon as the words "tomorrow," "next week," "next month," "next quarter," "next year," are used, the remainder of the sentence is a forecast. Generally, we can say that a forecast cannot be either entirely mathematical or entirely qualitative. It must be a blend of good mathematics and good common sense. Also, it can be said that the degree of accuracy sought in forecasting varies with different companies and industries.

FROM INTERNAL TO EXTERNAL FORECASTING

But how does the accountant fit into this picture? Traditionally he has supplied about one-half of the raw and processed data employed in forecasting. The accountant supplies the data for the internal forecast covering the operations and factors which can be controlled within the framework of the company organization. His responsibility deals, or should deal, with the following:

1. Forecast or budget of annual sales.
2. The establishment of a profit objective.
3. The establishment of a factory and headquarters expense budget consistent with the profit objective.
4. Forecast of product standard costs and variances at budget volume.
5. Forecast of operating profit or loss before taxes.
6. Forecast of taxable income, state and federal income taxes, and net income.
7. Establishment of capital investment programs and appropriation schedules.
8. Forecast of cash resources.
9. Forecast of cash requirements.
10. Forecast of new capital requirements.
11. Forecast of changes in assets and liabilities.

These responsibilities constitute the first of the accountant's roles in business forecasting. These items have a relationship to the entirety of forecasting which is often overlooked. Unless these individual forecasts are prepared, how can a company plan? The tendency to make organized labor a fixed cost; the increased cost of hiring and maintaining a labor force as a result of guaranteed annual wages, seniority, transferable pension rights and severance pay; and the problems of stabilizing employment require careful planning. In addition, the systematic projection of inventory needs and cost-price relationships is essential to maintaining a favorable competitive position. Fortunately much has been done to improve internal forecasting. New techniques have resulted in improved methods of solving problems concerned with decision-making.

But the accountant's responsibility does not stop there. It extends to the field of external forecasting and hence to Parts 2, 3, and 4 of the decision-making process, enumerated on a previous page. Any forecast which will be of value in this process must include both the internal forecasts and

an external forecast. It is this external forecast which is the disturbing element, so to speak. This is the forecast of conditions beyond the control of the individual company but which have an influence on its situation. Nor is such a forecast a secondary matter, even though we have reached it here by way of the accountant's primary responsibilities, for an external forecast should be made before the internal forecast is prepared. The latter will rely to some degree upon the external forecast, depending upon the scale of operations and the area from which purchases are made and that in which sales are made.

PROGRESS OF FORECASTING FROM BAD TO BETTER

This matter of external forecasting has been the biggest obstacle to effective business planning. All of the business functions, all of the management functions, and each step in the decision-making process can be studied in the light of internal, controllable, experience. But it takes a very capable (or else a completely unintelligent) man to make positive external forecasts. There are two aspects of external forecasting, industry or market-group forecasting and national forecasting.

In the case of industry or market-group forecasting, a considerable body of technique has been built up, although most of this has been on a trial-and-error basis. Trade associations and business associations have collected data, sampled intentions and presented forecasts, based generally on projections of total output, the volume of trade, new orders, inventories, construction, payrolls, etc. These are useful if the forecaster has knowledge of the company's projected relative position in the industry. But they are not particularly useful for local markets where competitive positions change and where, in fact, the business may be interested in improving its competitive position. Too frequently, these association forecasts are simple mathematical trend calculations which may be misleading for the individual firms. For example, such a projection of the farm population might indicate that there will be no farmers in Louisiana by 1970, a highly questionable conclusion.

What should be the accountant's role in this most neglected of the most neglected fields, the job of determining the external forecast for a particular company. It is, I believe, the new field in which the accountant should seek and accept responsibility, for he is in a strategic position to prepare a forecast without the optimistic bias of the sales manager or the conservative bias of the production manager. Also, he has the necessary mathematical skills, developed by his experience in internal forecasting. (He has certain handicaps, too, which I will reserve for discussion in a later paragraph.)

What are the objectives of an external forecast of general business conditions, national output or product, national income, indices of production, price indices, etc.? There are these objectives in the individual busi-

ness: to help shape over-all policies, and to establish a company forecast as a percentage or proportion of the national or regional market. They are highly important objectives. Yet, when we get into this field, we are sailing relatively uncharted waters. Although there was some business forecasting prior to 1930, the depression demonstrated clearly the inadequacy of the then accepted techniques.

But the late thirties and the war years saw changes. Greater stability had come to economics. (The economists still disagreed, but they were more precise in their disagreements.) The collection of data had improved. More data, more carefully selected were available. And the expanding market, an institution of our times, made forecasting easier. At least the direction was usually clear. However, the relationship between spending and the level of business activity, the status of investment spending, the problems of excessive saving, the relationship of monetary factors to business activity and the price level, the relationship between employment, income and money were all felt to be a matter of hypothesis.

SIGNS WHICH POINT TO FORECASTING AS THE ACCOUNTANT'S JOB

This brings up the question of where are we now. We have stated that the accountant is doing a good and constantly improving job of internal forecasting. We have stated that business must make external as well as internal forecasts. We have stated that the accountant should be responsible for external as well as internal forecasts. But we have also stated that no one, including all of the high-powered economists, is doing an excellent job of external forecasting. So why saddle the accountant with this new responsibility? The answer seems clear to me. These are the facts:

1. We must make external forecasts.
2. The accountant is in the best position to evaluate company progress.
3. The accountant has experience in internal forecasting.
4. The accountant has mathematical skills and aptitudes.
5. There are not enough economists in the country to staff every business.
6. The assignment does not logically fit any position description other than that of the accountant.
7. The accountant has sufficient intelligence to study economics in his spare time and acquire a working knowledge of economic factors in business life.
8. The science (or art) of business forecasting is improving so that there are principles and rules of the road to guide the new practitioner in this field.
9. Accounting equipment manufacturers will devote an increasing portion of their time to forecasting applications.
10. Forecasting may be done on a group basis, either through community efforts or through joint efforts by related business.

In summary, systematic, organized forecasting and planning is necessary to sound management and will be a widely recognized function in the very near future. Forecasting and planning are at long last receiving the

attention they deserve. The accountant will have an increasing responsibility for external forecasting, since he has the intellectual tools for this and since no one else is particularly anxious to accept this responsibility. My recommendations are:

1. The accountant should re-examine his responsibilities for internal forecasting for his company.
2. He should evaluate the techniques used by his firm in making internal forecasts.
3. He should study formal forecasting procedures and techniques to be sure that his firm is doing the best possible job.
4. He should direct his attention to the extent to which external forecasts are prepared, and should be prepared, for his company.
5. He should begin a study of, or refresh his knowledge of, the broad economic factors which affect business operations.
6. He should exchange his experiences and opinions with other local forecasters.

In short, the accountant should accept and seek the responsibility for both internal and external forecasting for his firm. By doing this, the accountant will broaden the scope of his responsibility and complete the natural implications of his function on the management team.

62. THE CONTROL FUNCTION OF THE ACCOUNTANT AS AN INDISPENSABLE PART OF MANAGEMENT

William J. Vatter*

The author describes the dual role of accounting in business; the audit function and the control function. The latter, identified with managerial accounting is discussed in its various aspects.

Accounting is a complex field—its interests run the entire gamut of human problems and relationships in the complex world of business. It is

* From *The Journal of Accountancy*, XCIII, 6 (1952), 705-10. Reprinted by permission of the author and the publisher.

not at all surprising that some phases of accounting and its functions tend to receive heavier emphasis than others. Accounting as related to its audit-public-information function is important—the tasks there to be performed are significant, and the problems complex. There is, however, another aspect of accounting, one that is concerned with the problems and processes of management within the company, rather than financial reporting to those outside. Perhaps we realize too little the nature of this division of accounting functions, and we recognize only partially how important is the control or managerial side of accounting, as distinguished from the audit or financial-reporting side. The position taken here is that the control side of accounting should be more widely understood and recognized; accountants should give more attention to the ways in which accounting procedures and the data these procedures can produce, are related to management needs and decisions.

A team of accountants from Great Britain visited the United States in 1950 to learn more about the ways in which accounting might be related to productivity. This team was impressed by the role of accounting in American industry; the following gives some idea of their reactions to the U.S. Accountant's role:[1]

> Parallel with the management's appreciation of accounting information, and contributing in large measure to this, is the controller's own understanding of management problems and technical processes. . . . The relationship of those who are responsible for finance, accounts and costing to management generally is of central significance. Its three special features are:
>
> (a) The desire of management to base its decisions on facts and reasoned forecasts and its consequent insistence on being given the necessary information and explanations;
>
> (b) The realization by both management and accountants that the primary purpose of accounts and costs should be to guide the management in planning the future and in deciding from actual results what has to be done to make the plan work. This is evidenced by the use of the title "controller" for the person in charge of the accounting and costing function;
>
> (c) The fact that the controller, or the person performing that function, though he does not have any executive authority outside his own department, belongs among top management and is consequently in direct contact with all their problems.

Accountants underemphasize the management side of accounting, despite the fact that the first and foremost function of accounting records and procedures is to facilitate management. This is understandable, of

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[1] *Management Accounting,* a report of the Anglo-American Council on Productivity, 1950, pp. 15, 18.

course. As we tend to specialize and professionalize accounting, we tend to think in terms of conventional standards and general procedures. This has the effect of making accounting a field of activity that is independent of management. Accountants have developed, as it were, a highly technical and intricate line of products, each displayed and merchandised as a specialty; despite the obvious merit of these products, their real worth derives from the raw material of which they are made—the data upon which all the specialties of accounting depend—information that reveals what is going on inside a business, in any or all of its various parts.

The emphasis given in accounting literature to issues and problems of the audit-public-information type is evidence that accountants tend to overlook the origins and the essentially managerial nature of their work. Accounting did not originate from the demands of investors, creditors, and government agencies. Although in its development these factors have tended to emphasize the public-information aspects of the field, accounting is still primarily a device to provide information for managers to use in making the decisions and in carrying on the operations within the firm itself.

Viewpoints and techniques of the accountant are useful and important to internal management, as is evident from the high percentage of every company's accounting costs that are incurred to collect information and to perform activities that have little direct relation to financial reporting as such. Further evidence of the importance of accounting for internal management is the extensive growth of the controller concept over the past two decades. What the accountant can contribute to management may be outlined here by examining the controller concept.

It is admitted that controllership cannot be defined in precise and unequivocal terms. The Controllers Institute itself has not been able to do more than to outline, in a general way, the nature of those tasks that it believes may logically and effectively be delegated to controllers and their staffs. Every company has its own set of circumstances and conditions in which the controller must operate; it is not likely that close agreement could be found among these companies as to just what a controller and his staff are supposed to do. However, there are four angles in the concept of controllership that may serve to show what is meant by the managerial side of accounting.

These angles of controllership are not functions or activities, though they may serve to define functions, or to determine activities. Rather, these four features are the attitudes, interests, and conceptions of the job which underlie and determine the kind of a contribution that the controller can and will make to management.

THE QUANTITATIVE VIEWPOINT

Accountants are useful to management because they epitomize the quantitative approach to the problems of business. This approach is an inherently logical, factual, and objective attitude, an emphasis upon collected and analyzed data, relatively unimpaired by personal judgments or subjective interpretations. Such an attitude does not deny the importance of qualitative factors, nor does it mean blind dependence upon facts for their own sake. It does mean that, in the search for data upon which to base decisions, diligence is applied to counting, measurement, or other quantitative presentation of the factors in a problem situation; effort is applied to state relationships in numerical terms so that the results are less ambiguous, more definite, and more easily comprehended by those who will use them. This emphasis upon quantitative data, to be handled logically in the honest attempt to be impersonal and objective in reports and analyses, is a primary characteristic of the accounting mind.

THE LONG-RUN VIEW

The second attribute of controllership may be described as an emphasis upon consequences of given events. This is a long-run view not in the sense of time, but in the sense that current activities build up ultimate effects. These ultimate effects are part and parcel of the current situation to the accountant, who strives to put together the consequences of an action with its occurrence. A businessman who is not an accountant may, in the press of everyday decisions, find himself pushed into situations in which the immediate demands may to him overshadow the consequences of his decisions. The controller tends to keep management "on the beam" by calling attention to these consequences. Even though the cash account may presently show no such effect, fixed assets depreciate; inventories need some degree of protection and control in view of the risks embodied in them. Income taxes do not occur once a year; they are increased or decreased by the transactions that occur from day to day. Without indulging in crystal-gazing or guessing about the future, the accountant and the controller recognize and remind management of the consequences of daily activities through the emphasis upon the long-run or ultimate effects of current activities.

The public accountant and the controller share this attribute, as they share the quantitative emphasis. Even when they may argue how the consequential effects of transactions ought to be handled, and the degree to which the element of forecasting ought to be recognized, they both tend to preserve this "long-run" attitude. The desire to consider and provide for the effect of day to day events in terms of ultimate consequences is an

attitude and an interest shared by both the controller and the public accountant, even though they have different ways to use and apply it.

The third attribute of controllership is the conviction that accounting procedures are the means of following up and checking upon the management decisions that have been made. This notion is not exactly foreign to the public accountant; I am sure that the issuance of enterprise reports to stockholders and the public is an aspect of it. But the controller sees this in a more specific, intra-enterprise, and day-to-day fashion. The basic notion of internal control is that of integrating the activities of the firm with the paper work in which the controller has an interest. This is not merely a means to insure that all transactions are recorded, and that all property is accounted for; rather, it is a device to minimize errors, fraud and waste. When he devises the system of paper work to accompany the regular operating activities, the managerial accountant is concerned with preventing incompletely or incorrectly handled sales orders, reducing unnecessary expenditures of money or other resources, avoiding misdirected effort. He is concerned with efficiency in the use of resources quite as much as he is with the prevention of losses by casualty or by fraud. He attempts to control sales activities through procedures having to do with unfilled orders; he insists upon reviewing purchase orders and other documents that have little or nothing to do with current income statements or balance-sheets. He is, above all, concerned with fixing responsibility for results, so that they will show how the actions and decisions of various officials have affected the enterprise. In short, the notion of internal control is a means of policing the programs and policies of the management, so that the accounting reports will show how and to what extent the management programs have been carried out.

Accounting textbooks recognize this only in part, and the public accountant uses the system of internal control only in part; the ordinary conception of internal control as a means of reducing the degree of verification necessary in an audit, or the prevention of fraud, is a decidedly narrower view of internal control than is envisaged by the controllers' conception of the system—policing the programs and policies of the management, so that management may know to what extent its operations are proceeding as they were supposed to.

Internal control and system are of course only a part of the policing process referred to here. Budgets and budget comparisons are another way in which controllers help management to check up on its own operations. To report what actually did happen as against what was planned for is to provide management with a definite check upon its own effectiveness. One of the most valuable services controllers can perform for their managements is to help them put their plans into such form, and

to match the actual performance against those plans on an independently impersonal physical or quantitative basis.

INTERPRETATION OF ENTERPRISE ENVIRONMENT

The fourth aspect of the managerial view of accounting is an application and extension of the quantitative emphasis, the long-run view, and the notion of systematic policing of management programs—in the full context of *environment.* The managerial accountant attempts to relate the data he collects and the procedures he adopts to all the conditions and influences that are related to the accounting figures. Accounting information from this viewpoint derives much if not all of its real meaning from the context in which it is observed.

To express the degree to which managerial programs are being carried out, it is necessary to have not only a statement or a blueprint of those programs in the form of a budget, and a related tabulation of the actual results, but it is also necessary to interpret the differences thus observed in terms of changes in prices, shifts in method of operation, changes in the rate of activity, and other factors which may be responsible for the differences between budget and actual results. Costs are not mere data; they must be examined and related to the decisions or other uses to be made of them; costs do not all "rank abreast," but rather are relevant or irrelevant, as the questions to be answered are different. A shift in price level must not obscure the changes in technical efficiency; past price levels must not confuse the issues of deciding upon future courses of action. All the changes in basic relationships or other factors in the environment of the firm must be analyzed so as to make them specifically separate. It is necessary to know where and how costs originate, how they ought to behave with respect to input, output, or other factors, and how they are affected by changes in the situation of the firm. It is therefore necessary to know not merely totals, but the different sub-classifications that may be useful for the various purposes that may have to be served.

Revenue in an aggregate amount for a given period may be reported as a single figure for purposes of financial reporting; for managerial purposes, such a figure is probably of little use unless appropriate breakdowns by territories, commodities, channels of distribution, terms of sale, or other bases, are available. This is because the issues and problems of sales management are related to the breakdowns of data, rather than to the aggregate amount.

In short, the managerial view of accounting includes an analytical, interpretive, and detailed expression of accounting information in terms of environmental situations, so that the results may be used for making decisions, and effecting the control of management. Data accumulated by

ordinary means may have to be adjusted, reclassified, or even "converted" into such forms as will enable management to see clearly not only what has been happening, but also the implications of those data for present and future courses of action.

These four attributes of managerial accounting may be seen at work in various ways. Perhaps it will make the position taken here a bit more clear if some illustrations are presented to show how the managerial viewpoint gains expression in practice.

THE WORKINGS OF MANAGERIAL ACCOUNTING

One example is to be found in the notion of using activities as a basis for account classification, rather than descriptive or natural classifications. To help management control operations, it is not enough to keep accounts to show separately cash and charge sales, nor merely to classify advertising as direct mail, newspaper or magazine. Both the revenues and the costs must be related to the activities that are being performed. Sales arising from a given segment of the market must be matched with efforts being made in that area, as directed by some executive and as measured by certain costs arising from his decisions.

Costs cannot be controlled merely by tracing them descriptively—as materials, labor, or indirect costs related to batch or unit or product. The only way costs can be controlled is by tracing them to activity-units—accounts representing operations over which some one executive has jurisdiction, in which certain activities are performed. Thus from the managerial viewpoint, costs are related to the activity unit first; costs are assigned to departments, divisions, sections, or areas within which the description of items as salaries, supplies, telephone, etc., have specific meaning. Thus, account classification should follow the organization chart, with descriptive titles used only within the organizational units; this is an unavoidable consequence of the managerial emphasis upon responsibility and control.

A second illustration arises from the fact that managerial accounting is projective rather than historical in emphasis. Unit costs to be used in determining price policy must be projected in terms of replacement costs—future costs if possible, but at least present costs—because the historical data is useful only to the extent that it serves as a basis for forecasting the future, when plans and policies are at stake. The emphasis upon budgets in managerial accounting is an example of the projective viewpoint. Here, the use of accounting data to project future operations is valuable not only in putting management's plans into dollar figures, but also to serve as a standard for interpreting the actual costs when they are measured. The budget cannot be simply historical, if it is to be used to measure future performance. In this connection, one of the principal advantages of stand-

ard costs is the ease with which intelligently set standards may be converted into prospective costs, as changes in prices, efficiency factors, and other circumstances may occur.

Managerial accounting is selective, rather than summational in character. By this I mean that relevant data are selected from the records and files to fit the problem at hand. To illustrate: when the question is raised as to whether a certain part should be purchased in finished form rather than to continue making it in the firm's own plant, the only costs that are relevant to this issue are those that can be saved by not making that part. When the issue arises as to whether a by-product should be processed beyond the split-off point rather than to be sold without further processing, the only costs of consequence are those which follow the separation of the by-product; the costs of processing before split-off are of no consequence. The question of whether output should be expanded beyond present levels must be met with a tabulation of those costs which will increase with an expansion of output; costs that are not changed by an increased output are irrelevant to such a decision. Thus, the collections of cost data are partial rather than complete tabulations; the parts of cost that are included in a calculation must be selected with a view to meeting the problem that is being considered.

Separating costs into fixed, variable, seasonal, and other patterns and classifications is another aspect of managerial accounting. This kind of analysis is based on the fact that it is the behavior of cost elements—not their average or aggregate amount—that is important for managerial purposes. A knowledge of these patterns of variability is not only useful in selecting costs that are relevant for certain decisions, but it is the prime basis for the construction of flexible budgets, and for the interpretation and control of costs.

The notion of cost patterns goes beyond merely the idea of variations in the rate of output. For instance, there are ways of relating cost behavior to the "mix" variation in producing an extensive line of products; costs may be variable or fixed with regard to the length of a production run, the size of purchasing quantity in a purchase order, and in various other ways. And the conception of cost variability can be applied to more situations than merely those of the flexible budget.

For instance, if the attempt is made to relate the activities and data of a flexible budget or a break-even chart to the income figure as reported by conventional means, there are discrepancies between the income figure and the break-even chart which arise from the conventional practice of including fixed costs in inventories. To meet this situation, it is entirely possible to set up an income statement arranged to differentiate between fixed and variable costs. Fixed costs under such an arrangement would be treated as costs of the period in which they were incurred, excluded from "manufacturing overhead" and inventories. This, of course, sets up an en-

tirely different notion of income from that of conventional accounting, but this different notion of income is more clearly related to management needs and management methods than is the conventional type of calculation.

PROMPTNESS VERSUS PRECISION

There is still another characteristic of managerial accounting which distinguishes it from conventional financial reporting. This is the attention paid to the need for prompt reports, even though some precision is sacrificed for promptness. Decisions can be made (indeed, they nearly always are made) from data that are somewhat lacking in accuracy; but decisions ought never be made on the basis of data that are stale, out of date, or which do not reflect current conditions. The striving for precise allocations and mathematical exactness (characteristic of double-entry bookkeeping and its consequences) are of some importance, of course; but precision and exactness are not so important as to delay essential information for managerial purposes. Partly from the standpoint of practical necessity, but more from the emphasis upon promptness, managerial accounting tends to sacrifice (whenever necessary) some degree of accuracy for the sake of prompt and current reports.

Mention should also be made here of the special timing and content of managerial reports. Certain data may be reported quite frequently—weekly, or even daily. The scope of managerial reports is of necessity flexible, so that accounting figures are transmitted in such forms as will meet the needs to be served by them.

Managerial accounting is, in summary, an attitude or a position with respect to the functions and purposes of accounting. From the managerial viewpoint, accounting is more concerned with activities than it is with descriptive classifications; it is more projective than historical; it tends to emphasize problems and purposes more than procedures; it stresses relevant data instead of accepted methods; and it aims at promptness even at the loss of some precision. This recognizes that the primary reason for the existence of accounting in any form is the use that management can make of it.

The managerial viewpoint deserves greater recognition in accounting practice, in accounting literature, and in accounting instruction. To hold this view does not mean that the independent audit function, its review of financial reporting, and the activities ordinarily considered to fall within the sphere of auditors are useless or of lesser consequence. Rather, the accounting profession should recognize both the audit and the managerial functions, and accountants should not overlook the opportunity for greater service by applying their intellectual and technical abilities to the furtherance of management.

63. MANAGEMENT MODELS AND INDUSTRIAL APPLICATIONS OF LINEAR PROGRAMMING

A. Charnes and W. W. Cooper*

The authors present illustrations of the application of linear programming with special emphasis on the use and applicability of this mathematical tool to planning and control. Although the article can be of maximum utility only to the person qualified by prior training to understand the mathematics involved, it can be profitably read by the nonmathematician who is interested in the applicability of linear programming. An appendix to the article together with a related bibliography of interest to the mathematician primarily are omitted.

1. INTRODUCTION

An accelerating increase in linear programming applications to industrial problems has made it virtually impossible to keep abreast of them, not only because of their number (and diversity) but also because of the conditions under which many are carried out. Industrial (and governmental) secrecy is often present. Other conditions also bar access to ascertainment and assessment of the pattern of applications. Lack of a tradition for publication is one. Failure to ascertain the general significance of particular findings is another, as is discouragement arising from the fact that similar applications have previously been published by others. Immediate remedies are not available for these difficulties.

A talk on "industrial applications of linear programming" must be altered to suit these circumstances. In place of a survey or evaluation of industrial studies, two broad issues which are relevant to all such applications will be discussed. These are, (1) use of linear programming models as guides to data collection and (2) analysis (and prognosis) of fruitful areas of additional research, especially those which appear to have been opened by industrial applications.

The first topic may be summarized in the statement that model formation and data requirements are twin aspects of the same process. The two should be regarded flexibly and, at different study stages, adjusted to each others purposes, limitations, and possibilities. The second topic (potential areas of research) will be based on our own experiences buttressed by reference to reports which we have been able to obtain access to. The discussion, largely conjectural in character, will center on the possible

* From *Management Science*, IV, 1 (1957), 38-91. Reprinted by permission of the authors and the publisher.

isolation of basic model types (and methods of approximation thereto) which might serve as building blocks in synthesizing more complete models for a wide variety of management planning problems.

2. PLANNING, OPERATIONS AND CONTROL

To clarify subsequent discussion, three areas of management activity may be distinguished: (1) planning, (2) operations and (3) control.

The planning phase of management (perhaps this should be called "pure planning") involves considering various proposals, assessment of alternatives—including procedures for insuring that all relevant alternatives are considered (explicitly or implicitly)—and tracing through and evaluating their consequences in order to map a course of action. The relative stress which is placed on the question of choice and the question of altering the range of choices will depend to some extent on the tier of management considered—e.g., top management or down the line—and other factors as well.

It will help to distinguish between planning and operations by regarding the latter as that stage of management in which resources are actually committed. Notice, in particular, that this distinction between plans and operations allows for some divergence between the two. The resource commitments which are planned may differ from those actually undertaken. It is probably even desirable to have such divergences especially when plans and operations are evolved by different persons or processes.

Analysis of these divergences between plans and operations requires recourse to the subject of management control. In fact, the question of conformance between plans and operations forms the core of the problem of management control. It must be remembered, however, that plans and operations are both subject to change in order to secure conformance. Exact conformance is, moreover, usually regarded as undesirable. It indicates lack of independence between the two sources of activity on which the controls themselves depend. In these respects (and others as well) standard versions of control in physical systems require adaptation before they can be translated satisfactorily for managerial application.

It is not possible to enter here into the ubiquitous problems of management control. The procedures involved are subtle, complex, and various. The topic is mentioned here primarily to lend perspective for subsequent discussion of planning studies. A good plan (e.g., a budget or a sales forecast) does not necessarily yield a good control. Usually some adjustments are necessary in passing from the planning to the control (or operating) stage. Indeed, the very procedures by which the participants are made a party to the plan are likely to require careful consideration when control is the objective.

Good planning data and good control data are not necessarily the same. It is possible that neither may prove suitable for operations. These distinctions should be borne in mind when forming (or testing) models in any of these three areas—planning, operations and control. The fact that most business decisions and data wind back and forth between these areas underscores the importance of keeping these distinctions in mind. Plans (or at least pure plans) should be formed and tested with reference to planning data. The fact that results do not square with operations is not decisive unless that is the area of analysis.

To date, linear programming applications have been, by and large, centered in planning. Applications to daily operations—e.g., blending models used by refineries—have been reported but sufficient details are not available for an assessment. There have been no applications reported in the control area.

3. CETERIS PARIBUS AND MUTATIS MUTANDIS MODELS

Linear programming models are *systems* models. Data requirements (and validity) should be judged accordingly. The requirements of system models (*vis a vis* data and objectives) are occasionally overlooked. It is therefore worthwhile to spend some time on this subject.

The point is simple but nonetheless important. It has received recent and explicit attention in the discussion of so-called "figures of merit"[1] in the literature of operations research. The choice of such figures of merit is important but their assessment for systems purposes is not always obvious. Consider, for example, the case of a manufacturer who wishes to minimize the total cost of meeting his orders. It may be difficult or impossible to ascertain the cost of producing the output required. The firm need not abandon its objective of cost minimization, however, simply because the indicated merit figure is not available. Recent research in linear programming has suggested that procedures may be available so that under fairly reasonable circumstances, surrogate variables may be used to substitute or "stand for" the missing cost figures. Thus, labor hours may be used as a surrogate and the total cost minimized by following prescribed scheduling procedures. The problem of cost minimization may then be regarded as solved provided management does not wish to know (or cannot know) the magnitude of these costs. Moreover, these procedures may optimize other criteria as well. Fluctuations in production rates, choice of optimum planning intervals and other such criteria can be comprehended by these same rules.

[1] A figure of merit may be briefly defined as the score (or scores) assigned to the outcomes which are possible under various plans. E.g., two different kinds of naval formations may yield different probable submarine "kills" or "contacts." The probable number of kills or contacts form the figures of merit for these possible plans.

How far (and when) one set of criteria—or figures of merit—may be used in place of another has not been fully assessed. This subject is, in principle, amenable to scientific research which will lead to a theory of surrogates. One by-product of current applications of linear programming and related techniques is increased knowledge of relevant management objectives (and criteria). This material is, moreover, now being reported in a form suitable for supplying guidance to scientific research. An example may be drawn from recent literature dealing with problems of forecasting and prediction for managerial purposes. Holt, Simon and Modigliani in their study of a paint factory[2] report that cost savings attributable to improvement in decision rules (of a mathematical programming variety) were found to be greater than those which could be attributed to elimination of forecasting errors. Modigliani and Hohn[3] have also shown that, under certain situations, only parts of an unknown product demand need to be accurately ascertained in order to schedule production optimally. Still other suggestions and findings are available.

It need not (and should not) be contended that either prediction problems or criterion-and-objective problems can be eliminated. Differing requirements in control, operations and planning have already been suggested as well as the issue of systems applications. A flexible use of programming models may sometimes reduce the apparent importance of issues of data collection, prediction and assessment. The use of surrogates has been mentioned and the development of more adequate means for dealing with numerous variables on a stochastic (conditional probability) basis offer further promise in this direction. Indeed, one contribution that linear programming may make is to reduce and simplify the data requirements of management planning.

A good deal of this planning is currently conducted on the basis of what may be called *ceteris paribus* models. Such a model alters one variable while holding all others constant. It may be distinguished from *mutatis mutandis* models in which all variables are adjusted to each such alteration. A study of proposed price variations for one product in a mix, holding all other products at given levels, is a *ceteris paribus* specimen. To convert it to a *mutatis mutandis* study all variables must be adjusted to the indicated change. Linear programming tends in the *mutatis mutandis* direction.

The requirements of data accuracy are likely to differ in the two cases. Thus a high degree of absolute accuracy may be necessary in a *ceteris paribus* study and not in its *mutatis mutandis* counterpart. As a rough

[2] C. C. Holt. H. A. Simon, and F. Modigliani, "Linear Decision Rule for Production and Employment Scheduling," *Management Science*, Vol. 2., No. 1.

[3] F. Modigliani and F. Hohn, "Solutions of Certain Problems of Production Planning Over Time Illustrating the Effect of the Inventory Constraint," *Econometrica*, January, 1956.

characterization of the latter case it may be said that it is better to have the data of relatively uniform quality (accurate or inaccurate) than to have part of the data highly exact and the remainder less so.

A simple machine loading model (Table I) will help to clarify (and qualify) these remarks. From the unit processing times presented in the body of the table, the machine capacities in the right-hand column, and the criterion elements in the bottom row the following direct and dual linear programming problems may be formed:

Direct

Maximize: $\$1x_1 + \$\tfrac{1}{2}x_2$
Subject to:

(1)
$$3x_1 + 2x_2 \leqq 12$$
$$5x \leqq 10$$
$$x_1, x_2 \geqq 0$$

Dual

Minimize: $12w_1 + 10w_2$
Subject to:

$$3w_1 + 5w_2 \geqq 1$$
$$2w_1 \geqq \tfrac{1}{2}$$
$$w_1, w_2 \geqq 0$$

TABLE I

MACHINE LOADING MODEL

	Direct / Dual	Maximize X_1	X_2	Stipulations (hrs.)	
minimize	W_1	3	2	$\leqq 12$	$= b_1$
	W_2	5	0	$\leqq 10$	$= b_2$
Criteria ($)		IIV $C_1 = 1$	IIV $C_2 = \tfrac{1}{2}$	Solution $3.50	

The solutions are as follows:

Direct

(2)
$$x_1 = 2, \qquad x_2 = 3$$
$$\$1x_1 + \$\tfrac{1}{2}x_2 = \$3.50$$

Dual

$$w_1 = \$.25, \qquad w_2 = \$.05$$
$$12w_1 + 10w_2 = \$3.50$$

Graphs of these problems are shown in Figures 1 and 2. The shaded areas are regions of feasibility and the solid lines their boundaries. The broken lines are the functionals for the direct and dual problems which attain their maximum and minimum values at the coordinates (2, 3) and (.25, .05), respectively.

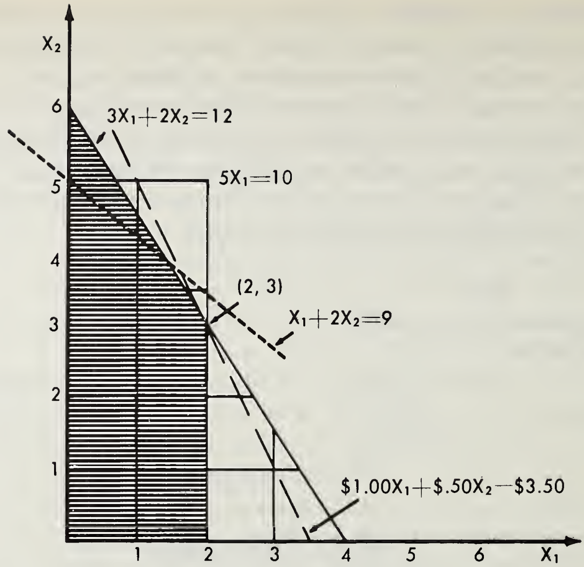

FIGURE 1

GRAPH OF DIRECT PROBLEM

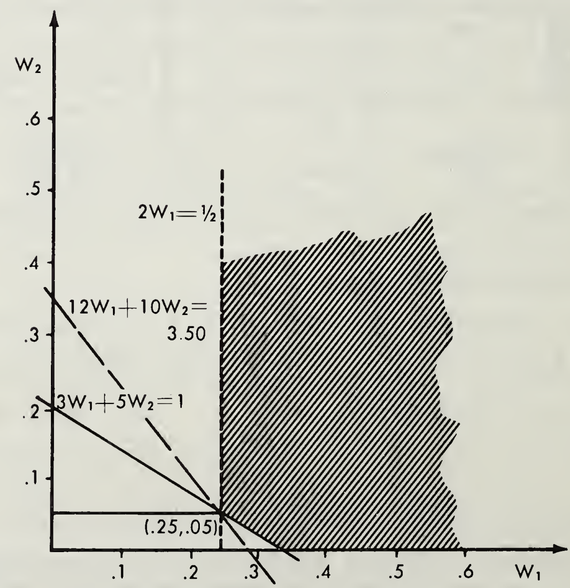

FIGURE 2

GRAPH OF DUAL PROBLEM

The dual variables, of course, provide evaluators for the stipulations in the direct problem. Thus, $w_1 = \$.25$ asserts that a one hour increase in the value of $b_1 (= 12)$ hours of capacity on the first machine will increase profits by \$.25. This increase is obtainable, however, only if all of the variables are adjusted, *mutatis mutandis,* to the new situation in order to achieve an optimum. Similarly, the value $w_1 = \$.05$ asserts that a one hour alteration in capacity for $b_2 (= 10)$ will only add \$.05 to total profit for the new optimum which it admits. Hence, at anything like the same cost for securing a one hour's alteration in capacity the first machine is to be preferred to the second when optimization is the objective.

How far do these values hold? What if inaccuracies in the data are present? Or, to align the discussion more closely with the preceding sections of this paper, how accurate must the data be for this model?

Consider, first, the unit profits for the direct problem. Let c_1 and c_2 represent any unit profit imputed to x_1 and x_2 respectively. Any ratio

$$\frac{c_2}{c_1} = \frac{1/2}{1} = \frac{1}{2} \tag{3}$$

will yield exactly the same optimum program ($x_1 = 2$, $x_2 = 3$) although total returns will, of course, alter with each choice of numerator and denominator. Moreover, the region over which this program will remain an optimum can be immediately ascertained by examining the possible rotations of the broken line in Figure 1 which do not force it into the interior of the shaded region. Different ratios are associated with different slopes of this line. Thus

$$\frac{0}{5} \leqq \frac{c_2}{c_1} \leqq \frac{2}{3} \tag{4}$$

prescribes the limits of tolerable error in unit profits—$66\frac{2}{3}\%$ in this case—for this program.[4] At the lower limit a new optimum (2, 0) is obtained and at the upper limit another optimum (0, 6) is also available. These are, however, alternate optima. The fact that they are available in no way affects the fact that (2, 3) retains its optimum character. So long as an optimum is desired, therefore, any ratio c_2/c_1 within this $66\frac{2}{3}\%$ margin of error will yield as good results as any other.

The same observations may be made with reference to the dual problem of Figure 2. So long as the ratio of the two machine capacities are in the following limits

$$\frac{0}{2} \leqq \frac{b_2}{b_1} = \frac{10}{12} \leqq \frac{5}{3} \tag{5}$$

[4] Only positive values of the c's and b's will be considered in order to avoid questions such as prices sufficient to cover average variable costs, etc.

the dual evaluators are unaffected. It still remains true that each hour's increase in capacity on the first machine will return (as a variable profit) five times as much as the second.

For example, let the capacity of b_2 be doubled, or raised from 10 hours to 20, while the capacity of b_1 remains fixed. This raises the capacity ratio to the upper limit in (5) and thus rotates the functional to a position of coincidence with the line $3w_1 + 5w_2 = \$1.00$ in Figure 2. An alternate optimum—at $(.33\frac{1}{3}, 0)$—is therefore available. This does not, however, affect the fact that $(.25, .05)$ remains an optimum.[5] The predicted program value $12w_1 + 20w_2 = \$4.00$ is obtained by using $x_1 = 4$, $x_2 = 0$ for the direct problem in place of the solution described in (2).[6]

This illustration can be extended in a variety of ways.[7] In the more complex examples encountered in "live" applications specific error analyses such as these may be obtained from information provided in the tableaus. Used with imagination or ingenuity, this information makes it possible to simplify the tasks of model construction and data assessment.

4. REDUNDANT CONSTRAINTS AND EXTRANEOUS VARIABLES

A redundant constraint enters into an optimum program with positive slack. An extraneous variable enters at zero. The omission of such constraints and variables offers a path for simplifying the initial models. They may be added at a later stage either by entering the solutions directly or, if there is some question about their status, by using the data of the tableaus either for purposes of testing or solution. Each tableau provides a linearly independent set of vectors which form a basis. By means of slack or artificial vectors an additional constraint may be introduced at any stage without disturbing previous calculations. If the constraint be critical rather than redundant the required new row in the tableau is

[5] The fact that uniqueness in the direct problem may exist alongside nonuniqueness in its dual does create "shadow-pricing problems" especially in the case of "delegation models."

[6] Thus the vertical constraint, $5\,x_1 = 10$, in Figure 1 is moved to the verge of redundancy. Any further movement in this direction will make this constraint entirely redundant. This is the meaning of the alternate optimum secured by the rotation in Figure 2. At such points management has to make up its mind, so to speak, with respect to future courses of expansion.

[7] E.g., both b_1 and b_2 may be simultaneously varied. Thus, if new levels $b_1 = b_2 = 15$ are inserted in (1) the new profit level will be \$4.50, an increment given by $\Delta b_1 w_1 + \Delta b_2 w_2 = 3 \times \$.25 + 5 \times \$.05 = \$1.00$. The dual method of C. E. Lemke (*Naval Research Logistics Quarterly*, Vol. I, No. 1, 1954) can be combined with the modified simplex method in order (a) to establish the limits for such variations and (b) to provide a systematic method for securing the new program values (starting from previously calculated tableaus) when these limits are violated. A code for such computations on an electronic computer has been developed by R. Graves of Standard Oil Co., Indiana.

easily obtained from the information which is already available. Additional variables may also be introduced by adjoining new columns to the tableau. Comparison with optima obtained prior to such alterations also provides by-product information such as the "opportunity cost" of additional restrictions. Rather simple modifications of the tableau makes it possible to use the inverse of the basis (which appears under the slack vectors) to effect a number of such extensions in relatively easy fashion.

No new constraint (in the same number of variables) can improve an optimum and no new variable (in the same number of constraints) can worsen it. By definition, neither redundant constraints nor extraneous variables can affect the value of an optimum program. They may have secondary effects, however, when considering the possibility of program alteration—e.g., in studying data inadequacies.

In principle a new variable, extraneous or not, always increases the sensitivity of a program by providing an additional dimension for variation. A new extraneous variable need not, however, cut down the minimum angle of rotation (in any direction) which determines whether a new physical program is required in order to achieve optimality.

A redundant constraint cannot decrease this angle of rotation. Consider the constraint

$$x_1 + 2x_2 \leqq 9 \tag{6}$$

with the boundary indicated by the dotted line in Figure 1. This may be interpreted, for example, as the limit allowed by a receiving facility for processing raw materials into the machines.

Clearly this constraint is redundant since the optimum program $x_1 = 2$, $x_2 = 3$ leaves one unit of slack in the receiving facility. Moreover, this constraint intersects one of the boundaries adjacent to the extreme point (corner point) optimum so that it can possibly become critical as a candidate for a "second best" program. Inspection of the diagram shows that it does not affect the minimum angle through which the functional may sweep, as shown in (4), so that it cannot affect this error range. It does, however, affect the error range in the dual by adding a new (extraneous)[8] variable for possible managerial evaluation. When the boundary is pierced by breaking the upper limit in (4) this constraint also reduces the range of possible program response and hence the possible optimum profit level as well.

These examples are relatively simple and are intended only to illustrate some of the ways in which programming models may be used to study aspects of the subject (such as data requirements) which are important for industrial applications. The spreading use of linear programming has stimulated scientific research. Models, methods and theorems are now

[8] Via the so-called theorem of the alternative the corresponding dual variable has the value zero.

available for handling a variety of problems. New applications will supply needed guidance for this research, especially as the really large and complex problems of management are brought into view and stated in a form which renders them suitable for scientific research.

Some of these needs are already apparent. Improved methods for obtaining approximate solutions will be required as well as methods for obtaining "advanced starts" which take full advantage of existing managerial "know how," experience and judgment. Bounding techniques,[9] dominance analyses and other such devices will also prove valuable (if not indispensable) as well as the types of redundancy and sensitivity analyses which have here been illustrated in an elementary fashion. Finally, more knowledge is needed of the nature of essential (and important) nonlinearities, if such there be, which are likely to occur in management-type problems.

New theorems and suitable notations which compress and simplify the tasks of analysis will undoubtedly be required. This is, of course, only another way of saying that new mathematics is needed. The field commonly thought of as applied mathematics has provided tools which have greatly aided progress in classical laboratory science. These tools have proved effective for dealing with problems of great subtlety. Management problems typically occur outside the laboratory. They may, in some respects, be less subtle than some of the traditional problems in mathematics but they are certainly complex in the sense that even though the relations involved often appear to be simple (when viewed separately) they are also likely to be numerous in kind and to involve a large number of interactions. Progress in handling problems of this character is vital for science (as well as mathematics) in order to continue extending its scope.

5. TYPES OF MANAGEMENT PLANNING MODELS

a. *Model Approximations.* Early research in linear programming was occupied with (1) devising general methods of solution and (2) establishing relations with other scientific disciplines. Considerable success has been achieved and more may be expected.

It will now be suggested, however, that progress in still other directions is essential for extending the area of industrial applications. In particular, special methods need to be developed which will make it possible to handle the truly large-scale management problems which are now coming into view. Various paths may be taken and numerous suggestions have been offered. One more may be ventured here, even though it be of a conjectural nature. Recent industrials applications have suggested the possibility that it may, perhaps, be possible to develop relatively few basic

[9] E.g., via the dual theorem.

model types which may be combined in various ways to comprehend a large variety of management problems. If this be true then research on special methods of solution and synthesis of particular models becomes more appealing from a scientific standpoint.

Numerous management models have now been developed often with specialized highly efficient methods of solution. The "machine loading" model of Table I is a case in point. One variant is the so-called "shop loading" model which assigns the same costs to each product irrespective of the technological process used. Central to both types of models—machine- and shop-loading—is a fundamental similarity of structure which renders differences in detail a relatively unimportant matter.

By the structure of a model is meant the patterns of coefficient arrays as well as their relative numerical magnitudes. Often the models for apparently dissimilar problems produce strikingly similar structures. Thus, structural properties originally identified with models for blending aviation gasolines have been found in sufficient number to make it appear worthwhile identifying a class of such blending models for fields such as producing animal feeds and fertilizer production, and in industry-wide studies as well as at the individual firm level.

To be sure the more basic models may often be mixed with other types in a larger structure. They may also present a different appearance under different modes of formulation. The constraints of a warehousing model, for example, may be taken up in a different manner when restated in the form of functional equations. These variations simply serve to extend the research issue to include proper methods of identification, transformation, decomposition and synthesis of the basic model types.

The preceding examples cover what may be called "exact" model types. The possibility of finding only a few basic model types which provide building blocks for a truly wide variety of management planning problems is enhanced by admitting model approximations as well.

The distinction between "exact" and "approximate" models may best be illustrated by examples. Consider Table II. It furnishes a systematic way of synthesizing the constraints for one of the best known (and simplest) of all linear programming examples, the so-called transportation model.[10]

A schematic array of these conditions is shown in Fig. 3. The coefficients of each relevant x is plus one or zero. The unit coefficients appear in the striking echelon-diagonal array shown in the table.

[10] Independently formulated by F. L. Hitchcock, "The Distribution of a Product from Several Sources to Numerous Localities," *Journal of Mathematics and Physics*, Vol. 20, and T. C. Koopmans, "Optimum Utilization of the Transportation System," *Econometrica*, Supplement, Vol. XVII.

TABLE II*

TRANSPORTATION TABLE

Destinations / Origins	D_1	D_2	D_3	D_4	D_5	Amount Required
O_1	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	5
O_2	X_{21}	X_{22}	X_{23}	X_{24}	X_{25}	5
O_3	X_{31}	X_{32}	X_{33}	X_{34}	X_{35}	6
Amount Available	2	2	4	4	4	16

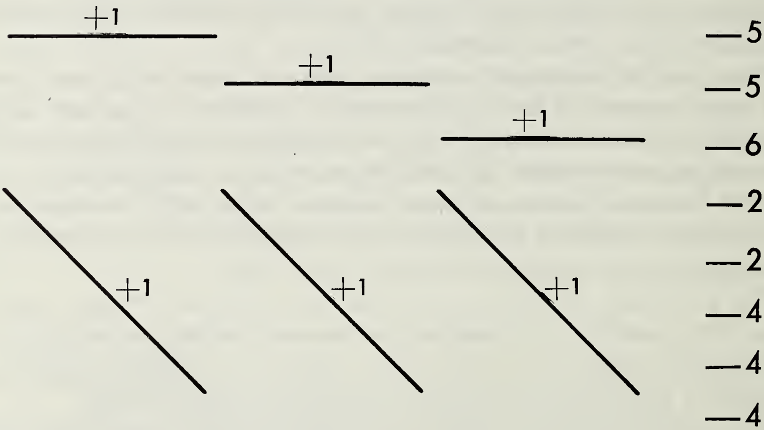

FIG. 3

TRANSPORTATION SCHEMA

The structure of this problem has attracted a good deal of attention. At an early date, G. B. Dantzig[11] devised an efficient computational tech-

* Source: A. Charnes and W. W. Cooper, "The Stepping Stone Method of Explaining Linear Programming Calculations in Transportation Problems," *Management Science*, Vol. 1, No. 1, October, 1954.

[11] T. C. Koopman, (ed.), *Activity Analysis of Production and Allocation.* Cowles Commission for Research in Economics, Monograph No. 13, New York: John Wiley & Sons, Inc., 1951. G. B. Dantzig, "Application of the Simplex Method to a Transportation Problem."

nique. By reference to the dual of this problem he noted that row numbers, R_i, and column numbers, K_j, could be assigned to each occupied cell in an array such as Table II. Starting with one arbitrary row or column number the remaining values can be ascertained rapidly by reference to the unit costs, c_{ij}, associated with each cell for which a routing is scheduled. At each stage, a test of optimality is thereby provided by reference to the vacant cells and an optimum program finally obtained.

Further research has since yielded improvements in these methods. The initial versions of the "transportation" model have also been extended in a variety of directions: problems in personnel assignment, flows of current (or traffic) through a network, aircraft maintenance, determining engine-crew assignments for freight loads, minimization of machine set-up times, etc., have thus been comprehended in one class of linear programming models, or their game theoretic counterparts.

These models are all "exact" for at least extended versions of the transportation model. Consider now how even this more extended scope may be widened by reference to "model approximations." Table III will be used for illustration.[12] It is an expanded version of a machine loading model of the kind previously discussed. The first five rows under P_0, the stipulations column, lists the machine capacities. Sales restrictions, stating the maximum amount of each product which the market stands ready to absorb, are shown in the following ten rows. The ten products, π_1, π_2, $\cdots$, π_{10} and the relevant unit profits are listed across the top of the table. The symbols P_1, $\cdots$, P_5 indicate alternate processes for producing π_1; P_6, $\cdots$, P_9 are alternate processes for π_2; and so on.

The pattern of echelon-diagonal arrays which stand forth in this table are suggestive of a transportation model. It fails in only two respects: (a) the arrays of echelons and diagonals are not of equal length and (b) some of the non-zero coefficients are not unity. The first defect is easily remedied by inserting artificial processes with large penalty rates, $\$(-M)$, in the usual manner (in order to assure that these processes will not be used in an optimum program). The second defect may be adjusted (though not perfectly) by a variety of devices.

In this case, as often happens, there is a rough proportionality[13] in the machine times for (a) different machines which might be employed on the same product and (b) the same machine employed on different products. The following two rules, which are available for scaling any linear programming problem, may therefore be used to bring these elements "close" to unity:

---

[12] The authors are indebted to Mr. F. G. Walker and D. Jennings of the Management Services Department, Touche, Niven, Bailey and Smart with whom they were associated in the research underlying this example.

[13] When this proportionality is absent—e.g., in multi-stage processes—the standard rules of calculation need to be altered.

(i) *Row rule:* Multiply any row (including the element in the stipulations column) by a positive number.

(ii) *Column rule:* Multiply any column (including the criterion element) by a positive number.

The scaling factors used in this case are shown in the right-hand column and bottom row of Table III. Thus, upon multiplying the first row by 1/.534, the reciprocal of the machine time under P_1, the 6864 available hours under P_0 are converted to 12,854 tons, the value under P_1 becomes unity, the value under P_{14} becomes .448/.534, and so on. After each of the five rows are thus scaled by the row rule, attention is turned to the column rule. The values under π_1 require no further adjustment since they have already been converted to "ones." (See Table IV.) The median values remaining under each of $\pi_2, \pi_3, \cdots, \pi_{10}$ after the row scalings, are then used to provide additional scalings for each product. For example, .469/.501 is selected as the "median" under π_2. The reciprocal of this factor is then used to scale each column under π_2. The values .480/.511, .415/.471, .469/.501, .245/.246 which resulted from the previous row scalings used in these columns are then each multiplied, in turn, by .501/.469 to yield (to something less than slide-rule accuracy) 1, .94, 1, 1.06, as shown in Table IV. The c's appearing at the top of each of these columns must, similarly be multiplied by this same scaling factor and the unity elements (opposite the relevant sales restrictions) as well. Scaling of these unity elements may, however, be omitted since these rows are rescaled at the next stage by the reciprocals of these medians, as shown in the right-hand column under the row adjustment factors for rows 6 through 15. It is necessary, therefore, only to remember to alter the sales stipulations by these reciprocals at the next stage.

The results of these scaling operations are shown in Table IV. The figures are deemed to be close enough to unity to warrant classification as an approximate transportation model and to justify recourse to the transportation routines in order to secure an approximate optimum. This can be done by inserting "slack" and "artificial" variables as required. Within the accuracy of the data the solution thus secured is often sufficient. Such solutions may always be "bounded" relative to the true optimum and, if desired, an exact solution obtained from a relatively advanced start. Present purposes are therefore served by identifying this scaled machine loading as an approximate transportation model. By suitable extensions, multi-stage machine processes and balance restrictions (minimal as well as maximal) may also be handled.

Via this approximation concept the seemingly distinct models of machine (and shop) loading, transportation, and other problems as well may be classified within the one rubric. Still other examples can be cited.

TABLE III

MACHINE LOADING—MAXIMUM SALES RESTRICTIONS WITH SCALING

ADJUSTMENT FACTORS

	Stipulations	Inequality	STRUCTURAL VECTORS																					Row Adjustment Factors Used
			π_1					π_2				π_3		π_4		π_5		π_6	π_7		π_8	π_9	π_{10}	
	Ci		80.76	70.77	76.15	65.30	79.11	119.49	89.09	75.30	116.30	91.49	102.11	64.14	54.13	62.98	64.14	86.25	45.57	29.03	39.87	42.05	38.23	
	Po		P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}	
MACHINES	(hrs.) 6,864	$\geqq$	.534													.448			.427			.496	.440	1/.534
	6,864	$\geqq$		.511				.480				.473												1/.511
	6,864	$\geqq$			.471				.415				.424	.376				.436						1/.471
	6,864	$\geqq$				.501				.469										.456				1/.501
	6,864	$\geqq$					.246				.245				.183		.236				.248			1/.246
SALES RESTRICTIONS	(tons) 126,151	$\geqq$	1	1	1	1	1																	None
	11,714	$\geqq$						1	1	1	1													$\frac{.469}{.501} = .94$
	11,463	$\geqq$										1	1											.91
	10,776	$\geqq$												1	1									.76
	5,679	$\geqq$														1	1							.90
	3,410	$\geqq$																1						$\frac{.436}{.471} = .93$
	2,834	$\geqq$																	1	1				.86
	1,109	$\geqq$																			1			$\frac{.248}{.246} = 1.01$
	948	$\geqq$																				1		$\frac{.406}{.534} = .93$
	144	$\geqq$																					1	$\frac{.440}{.534} = .82$
Column Adjustment Factors Used			None					$\frac{.501}{.469} = \frac{1}{.94}$				$\frac{1}{.91}$		$\frac{1}{.76}$		$\frac{1}{.90}$		$\frac{.471}{.436}$	$\frac{1}{.86}$		$\frac{.246}{.248}$	$\frac{.534}{.496}$	$\frac{.534}{.440}$	

Note: Machine capacities are stated in available hours, sales restrictions in tons of products.

TABLE III-A

RECONVERSION TABLE AND PROGRAM $7,240,961

Row Numbers	Column Numbers / Products / Machines	0	$119 - \frac{.480}{.511} \times 71 = 52.31$	$102 - \frac{.424}{.376} \times 64 = 29.83$	0	0	$86 - \frac{.436}{.376} \times 64 = 74.21$	0	0	0	0	0	Machine Capacities
		π_1	π_2	π_3	π_4	π_5	π_6	π_7	π_8	π_9	π_{10}	$\pi\phi$	(hrs.)
$\frac{81}{.534} = 151.68$	M_1	81 .534 12854				63 .448		46 .427		42 .496	38 .440	0	6,864
$\frac{71}{.511} = 138.94$	M_2	71 .511 2429	119 .480 11714	91 .473								0	6,864
$\frac{64}{.376} = 170.21$	M_3	76 .471	89 .415	102 .424 11436 −	64 .376 1374 +		86 .436 3410					0	6,864
$\frac{65}{.501} = 129.74$	M_4	66 .501 13701	75 .469					29 .456				0	6,864
$\frac{79}{.246} = 321.14$	M_5	79 .246 27902	116 .245		54 .183	64 .236			40 .248			0	6,864
0	$M\phi$	0 69265 +	0	0	0 9402 −	0 5679	0	0 2834	0 1109	0 948	0 144	0 .404 84847	(tons) 174,228
Limits on Product Demand (Tons)		126,151	11,714	11,463	10,776	5,679	3,410	2,834	1,109	948	144	(hrs.) 34,320	208,548

TABLE III-B

OPTIMUM PROGRAM: $7,252,844

Row Numbers	Column Numbers / Products / Machines	0	$119 - \frac{.480}{.473}\left[91 - 102 - \frac{.424}{.376} \times 64\right] = 57.9$	$102 - \frac{.424}{.376} \times 64 = 29.9$	0	0	$86 - \frac{.436}{.376} \times 64 = 11.8$	0	0	0	0	0	Machine Capacities
		π_1	π_2	π_3	π_4	π_5	π_6	π_7	π_8	π_9	π_{10}	$\pi\phi$	(hrs.)
$\frac{81}{.534} = 152$	M_1	81 .534 12854				63 .448		46 .427		42 .496	38 .440	0	6,864
$\frac{91}{.473} - \frac{102}{.473} + \frac{.424}{.376} \times \frac{64}{.473} = 129.3$	M_2	71 .511	119 .480 11714	91 .473 2624 +								0	6,864
$\frac{64}{.376} = 170.1$	M_3	76 .471	89 .415	102 .424 8839 −	64 .376 4334 +		86 .436 3410					0	6,864
$\frac{65}{.501} = 129.5$	M_4	66 .501 13701	75 .469					29 .456				0	6,864
$\frac{79}{.246} = 320.1$	M_5	79 .246 27902	116 .245		54 .183	64 .236			40 .248			0	6,864
	$M\phi$	0 71694 +	0	0	0 6442 −	0 5679	0	0 2834	0 1109	0 948	0 144	0 .401 85378	(tons) 174,228
Limits on Product Demand (Tons)		126,151	11,714	11,463	10,776	5,679	3,410	2,834	1,109	948	144	(hrs.) 34,320	208,548

It is better perhaps, to forego a more extended discussion of these cases in order to offer conjectures on other possible candidates for basic model types.

b. *Hierarchical, Hierarchoid and Delegation Models.* It is not possible at this time to compile either an exhaustive or decisive list of potential candidates. It is important, however, to ensure that consideration is given to a wide variety of industrial-type problems. Attention will therefore be turned to problems where extension or interpretation is required in order to bring them into focus as linear programming problems. Hierarchical models, hierarchoids and delegation models will therefore be briefly discussed.

Dominances and redundancies are extreme examples of an hierarchical art arrangement. More generally, an hierarchy states the constraints in the following form

$$\sum_{j=1}^{n} a_{(i-k)j}x_j \leqq \sum_{j=1}^{n} a_{ij}x_j, \qquad i = 1, 2, \cdots, m, \tag{7}$$

so that the problem is one of determining values $x_j \geqq 0$ which yield the desired ordering. When these constraints are interpreted probabilistically —viz.,

$$P\left\{\sum_{j=1}^{n} a_{(i-k)j}x_j \leqq \sum_{j=1}^{u} a_{ij}x_j\right\} \geqq a_{ik}, \tag{8}$$

with P for probability and α_{ik} a prescribed confidence coefficient, an hierarchoid arrangement is achieved.[14]

Little attention appears to have been devoted to models of this kind, despite their rather apparent appeal in terms of, say, usual forms of business organization. One such example has been reported in the form of a linear programming application to the problem of determining executive compensation patterns in an industrial organization. This report focussed on the relevance of the methods there used (a) for dealing with nonlinear functionals and (b) for treating statistical regressions which are subject to inequality constraints. The objective in this problem (meeting competition "as closely as possible") as well as the criterion elements, can also be given an economic interpretation, which aligns it more closely with the usual form of linear programming objectives—cost minimization, profit maximization, etc. The model is, to be sure, probabilistic in nature. It is, nevertheless a cost minimizing model if the objective is interpreted

[14] Usually prescribed constants—ceilings, floors, and intermediate values—are inserted at various points in the constraints.

TABLE IV

SCALED MACHINE LOADING PROBLEM

Stipulations (tons)		Inequality	π_1					π_2				π_3		π_4		π_5		π_6	π_7		π_8	π_9	π_{10}
	C'_j		80.76	70.77	76.15	65.30	79.11	127	95	80	123	101	112	84	71	70	71	93	53	34	40	45	46
	P_0		P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}
MACHINES	12,854	$\geqq$	1													.93			.93			1	1
	13,432	$\geqq$		1				1				1.02											
	14,573	$\geqq$			1				.94				.99	1.05				1					
	13,701	$\geqq$				1				1										1.06			
	27,902	$\geqq$					1				1.06				.97		1.07				1		
SALES RECONSTRUCTION	126,151	$\geqq$	1	1	1	1	1																
	11,011	$\geqq$						1	1	1	1												
	10,431	$\geqq$										1	1										
	8,190	$\geqq$												1	1								
	5,111	$\geqq$														1	1						
	3,171	$\geqq$																1					
	2,437	$\geqq$																	1	1			
	1,120	$\geqq$																			1		
	882	$\geqq$																				1	
	119	$\geqq$																					1

TABLE IV-A

SCHEDULE OF RATES ($ PROFIT/TON) AND AVAILABILITIES

Origins \ Destinations		PRODUCTS											TOTAL (hundreds of tons)
		π_1	π_2	π_3	π_4	π_5	π_6	π_7	π_8	π_9	π_{10}	π_ϕ	
MACHINES	M_1	81	−M	−M	−M	70	−M	53	−M	45	46	0	128
	M_2	71	127	101	−M	−M	−M	−M	−M	−M	−M	0	134
	M_3	76	95	112	84	−M	93	−M	−M	−M	−M	0	146
	M_4	65	80	−M	−M	−M	−M	34	−M	−M	−M	0	137
	M_5	79	123	−M	71	71	−M	−M	40	−M	−M	0	279
	M_ϕ	0	0	0	0	0	0	0	0	0	0	0	1686
TOTAL (Hundreds of tons)		1261	110	104	82	51	32	24	11	9	1	825	2510

TABLE IV-B

AN INITIAL SOLUTION $7,202,000

Row Nos. Ri	Column Nos. Kj	0	54	28	0	0	9	0	0	0	0	0	TOTAL
	Origins \ Destinations	π_1	π_2	π_3	π_4	π_5	π_6	π_7	π_8	π_9	π_{10}	π_ϕ	
81	M_1	81 (128)				70		53		45	46	0	128
73	M_2	71	127 (110)	101 (24)								0	134
84	M_3	76	95	112 (80)	84 (34)		93 (32)					0	146
65	M_4	65 (137)	80					34				0	137
79	M_5	79 (279)	123		71	71			40			0	279
0	M_ϕ	0 (717)	0	0	0 (48)	0 (51)	0	0 (24)	0 (11)	0 (9)	0 (1)	0 (825)	1686
Total		1261	110	104	82	51	32	24	11	9	1	825	2510

TABLE IV-C

AN OPTIMUM PROGRAM FOR THE TRANSPORTATION MODEL $7,250,000

Row Nos. R_i	Column Nos. K_j	0	44	18	-10	0	-1	0	0	0	0	0	TOTAL
	Origins \ Destinations	π_1	π_2	π_3	π_4	π_5	π_6	π_7	π_8	π_9	π_{10}	π_ϕ	
81	M_1	81 128				70		53		45	46	0	128
83	M_2	71	127 62 −	101 72 +								0	134
94	M_3	76	95	112 32	84 82 +		93 32					0	146
65	M_4	65 137	80					34				0	137
79	M_5	79 231 −	123 [illegible] +		71	71			40			0	279
0	M_ϕ	0 765 +	0	0	0 √	0 51	0	0 24	0 11	0 9	0 1	0 825	1686
Total		1261	110	104	82	51	32	24	11	9	1	825	2510

by reference to standard versions of the economic theory of distribution. By meeting competition as closely as possible the firm seeks to minimize the total cost of holding (and attracting) a representative mix of the executives required to man the company's organization. For, by standard versions of distribution theory in economics, the potential productive contribution of any executive[15] (value in dollars) sets an upper limit to his worth to the company. Offers by competition provide a lower limit. Hence the objective, of meeting competition as closely as possible, is also an attempt to reach the lowest cost level that the company's organization allows, on the assumption that this representative mix is worth at least as much as the competition offers.

To be sure, some reaches in the hierarchy will be compensated at lower values and others at higher values relative to competitive offers. The assumption is that these will cancel out in an over-all sense and provide the necessary degree of attraction throughout the hierarchy—including "representative" leakages and additional recruitment. When desired, weights

[15] Some adjustment of standard versions of the economic theory of distribution is required, of course, in order to consider executive posts in a hierarchy since the usual versions of this theory do not allow for such "factors" or the possible attraction of "promotions" to other echelons in the hierarchy. The probabilistic context of the problem also requires further adjustment in this theory.

can be inserted in the functional to allow for the relative importance assigned to various rankings which can, alternatively, be interpreted either as measures of the relative force of competition in each such bracket or else as an allowance for productive contributions in the various hierarchies.

The model used in this instance is, of course, too simple to bear the entire weight of potential linear programming applications to problems of organization planning, relative priority or preference, etc. Other parts of programming—e.g., constrained games[16]—will need to be adjoined for further penetration into these areas. At any rate, the main issue is not this particular instance. The question is whether hierarchical and hierarchoid models are, potentially, fundamental types. A plausible argument for their candidacy appears to be possible.

Delegation models appear to be another class of candidates. T. C. Koopmans "activity analysis models"[17] are an example. In fact, little progress, at least as far as industrial applications are concerned, appears to have been made since Koopmans' original research. Perhaps this has resulted from the rather extreme example used by Koopmans, a completely delegated, almost egalitarian model of an organization. Perhaps the orientation toward the general problems of an economic system, in the classical tradition, or Koopmans' lack of detailed attention to expedient computation devices account for the fact that inadequate attention has been devoted to the possible value of further developments for industrial applications. This situation should be remedied by devoting attention to the adaptations, modifications and extensions required to make these models suitable for industrial applications.

It is true that Koopmans' formulation needs to be interpreted if it is to be brought within the framework of the more usual forms of linear programming. It is not one, but a series of linear programming problems. The crux of Koopmans' formulation rests on the concept of efficiency prices. These prices, or their "accounting" counterparts, are intended as internal guides for a decentralized organization—analogous to, say, the so-called internal profit-and-loss control systems employed by many large commercial organizations.[18] The objective is to supply price guides, including

[16] The initial use of "ordinal" probabilities with imputed dollar valuations, and other relevant commercial interpretation of strategic components which seem to arise in rather natural fashion from these kinds of game formulations provide an attraction for possible applications.

[17] T. C. Koopmans (ed.), *Activity Analysis of Production and Allocation,* Cowles Commission for Research in Economics, Monograph No. 13, New York: John Wiley & Sons, Inc., 1951. T. C. Koopmans, "Analysis of Production as an Efficient Combination of Activities."

[18] *Vide,* Peter Drucker, *The Concept of the Corporation* (New York: John Day and Co., 1946) for a discussion of the system employed by the General Motors Corporation. Gregory Brenstock, Aaron Yuzow and Solomon Schwartz, *Management in Russian Industry and Agriculture* (London: Oxford University Press, 1944) describe a system used by the Soviet Government.

prices of fixed facilities, which can be used for bidding by the various departments both for services supplied within the firm itself and from outside sources.

In order to see what is involved the machine loading example of sections 3 and 4 may be used even though a "forced" interpretation is required in order to fit it into the activity analysis mold. Table V provides the necessary extension by incorporating and two other conditions—e.g., raw materials supplied from inventory—in order to complete the illustration. Each column of the Table represents an "activity" and each row a "commodity." The variables x indicate the levels at which the activities are to be run and the values y represent the corresponding amounts of each commodity. The commodities (goods or services) are divided into final, y_1 and y_2; primary, y_3, y_4 and y_5; and intermediate products, y_6 and y_7. These divisions correspond to the relations the variables, y, bear to the stipulations and to sign conventions used to distinguish between inputs and outputs. Final products (y_1 and y_2) are constrained to be non-negative, primary ones (y_3, y_4 and y_6) are constrained to be non-positive and to conform to stipulated limits while intermediate products (y_6 and y_7) are zero. Within any column (in the body of the table) a negative sign attached to any coefficient designates an input to the activity and a positive sign an output.

Koopmans' organization model may be summarized as follows: Each commodity (row) is placed in charge of a custodian and each activity (column) in charge of a manager.[19] Custodians and managers are each to maximize their own "profits." The issue is whether it is possible for a central office committee—a "helmsman" in Koopmans' terminology—to

TABLE V

ACTIVITY ANALYSIS MODEL

ACTIVITIES				Net Outputs and Inputs	Stipulations
X_1	X_2	X_3	X_4		
1				Y_1	$\geqq 0$
	1			Y_2	$\geqq 0$
-3	-2			Y_3	$\geqq -12$
-5				Y_4	$\geqq -10$
-1	-2			Y_5	$\geqq -9$
-1	-1	1		Y_6	$= 0$
		-1	1	Y_7	$= 0$

[19] This terminology is borrowed from Koopmans.

devise a system of prices, or price rules, which will guarantee certain results (not necessarily optimal) to the over-all entity. As has already been indicated, only limited guarantees can be offered unless further intervention is allowed. Under certain circumstances efficiency can be achieved. Moreover, as Koopmans shows, by following specified rules of pricing both "inside" and "outside" transactions may be comprehended by these efficiency conditions.

It is important to emphasize both the differences and similarities that exist between Koopmans and the linear programming approaches that have previously been presented. In one interpretation an efficient program is only one that is not obviously wasteful. Thus a point y with coordinates y_i, $i = 1, 2, \cdots$, is said to be efficient if and only if there does not exist a point $\bar{y}$, with coordinates $\bar{y}_i$, $i = 1, 2, \cdots$, which is better. The term "better" is used in the sense of a partial ordering: No coordinate of $\bar{y}$ is less than the corresponding coordinate of y, and at least one coordinate is greater. Formally, $\bar{y}$ is better than y if

$$\bar{y} \geq y, \tag{9}$$

where "$\geq$" means $\bar{y} \geqq y$ and $\bar{y} \neq y$. If such a point $\bar{y}$ is available, then y is not efficient.

There are, to be sure, many problems which need to be considered before introducing this concept into an industrial organization. It does, however, have two virtues. First, it focusses attention on the fact (not always recognized in currently employed internal pricing systems) that (a) the maximizing objectives of any particular supervisor[20] and of the over-all entity may conflict and (b) the objectives of the various supervisors may also fail to coincide. In short, the improvement secured by one may worsen the position of others. Second, there are regions in which the improvement secured by any supervisor redounds not only to his own benefit but also to the benefit of the entity and, perhaps, other supervisors as well. Thus, if y is not efficient then it is possible for at least one custodian or manager (under properly conceived price rules) to improve his own position without worsening the lot of any other custodian or manager. The prices designed to produce the "correct" behavior under these circumstances are the efficiency prices.[21] Although dynamics of these price arrangements have not been fully worked out, it is possible to ensure, under certain circumstances, that custodians and managers dealing with each other will not be foregoing benefits which they might otherwise obtain by dealing with sources outside the entity.

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[20] The term supervisor is here used to refer to both custodians and managers.

[21] A more general formulation would specify other kinds of information, or "misinformation," to be supplied as a means of correcting potential misbehavior by supervisors. This kind of extension is being studied by the authors in collaboration with Martin Shubik of the General Electric Co.

Koopmans has made one start on problems which are important in cost allocations as well as in organization theory. In dealing with the question of multiple objectives it was necessary for him to alter features of the usual linear programming model. The usual objective, scalar optimization of a single quantity (e.g., total profits or costs) is replaced by a problem in vector optimization. The activity analysis approach can be reconciled with linear programming. It replaces one linear programming problem by a series of such problems and their duals.

It is conceivable that incorporation of hierarchical and hierarchoid arrangements into the models of activity analysis may provide a start toward adjusting them for industrial applications. But the activity analysis approach is important in its own right. The relations between linear programming and zero-sum two-person games are well known. It is possible that the activity analysis approach may provide a similar bridge for other types of games as well. The so-called Pareto-Nash equilibrium points in non-cooperative game solutions suggest an affinity and common origin with Koopmans' approach. Extended versions of delegation models may also offer a means of dealing with some of the difficult problems of suboptimization that are often faced in applied work. In particular, it should be possible to evolve methods for imputing prices (initially or finally) to omitted elements of the system. These possibilities alone would seem to warrant the further research required for industrial applications.

6. CONCLUSION

It has been possible within the scope of this paper only to touch on a variety of topics. Other, perhaps equally important, topics have perforce been either omitted or treated too lightly. The work of Bellman and others in dynamic programming has been too slightly treated and the same is true of recent work in quadratic programming, sequencing, line balancing inventory control, and other areas as well. The title assigned to this paper can serve as an excuse but not as a justification, for omitting any reference to reported studies in farm management, engineering design and other topics closely allied to industrial programming.

The conjectural nature of some of the topics covered in this talk, especially those dealing with the idea of basic model types, should be underscored. However, these concepts are useful in any event as a guide to approximations.

Having proceeded thus far into the realm of conjecture it is perhaps as well to proceed a step further. This will at least help to close the discussion on a more positive note and to sharpen the potential relevance of such work for progress in management science. It is sometimes stated that this science (or body of sciences) is lacking in parameters analogous to, say, gravitational constants, etc., which have played such critical roles in other

disciplines. This criticism, though relevant, need not be decisive at this stage of development. Possible differences in management and these other sciences must be allowed for. It may be, as the discussion throughout this paper suggests, that no such isolated (or isolable) constants will ever be discovered. It appears more likely that such parameters, if they exist, will make their appearance in the form of systems or even constellations of systems. If this be true then progress in management science depends critically on (a) the evolution of appropriate methods of systems analysis and (b) the development and identification of basic management models which can comprehend such constellations in understandable form. Linear programming has provided one avenue for a start in this task, especially in the field of industrial applications. Doubtless other avenues are (or will be) opened by other approaches as well.

XVII

COST ANALYSIS

64. THE CONTRIBUTION OF MARGINAL COSTING TO PRESENT-DAY PROBLEMS

W. E. Harrison*

The author presents the case for marginal cost in making decisions involving alternatives. The proper treatment of fixed costs is stressed and short period versus long period treatment is differentiated.

DEFINITION

Marginal cost may be defined as the amount, at any given volume of production or output, by which aggregate costs are changed if the volume of production or output is increased by one unit. In more simple terms, if, starting from the position we are in now, we produce one more of a certain product, the added expenditure entailed is the marginal cost of that product.

The main feature of a marginal costing system is the separation of the variable costs from the fixed costs of a business, and the control of each type by varying methods, so as to give maximum efficiency, and to reveal the effect upon profit of changes in output.

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* From *The Cost Accountant*, XXXIII, 4 (1954), 121-28; paper first delivered in May, 1948. Reprinted by permission of the author and the Institute of Cost & Works Accountants, Ltd.

THEORY OF MARGINAL COSTING

It is not intended to list the duties and functions of the cost accountant, but as an aid to management he must:—

(*a*) provide facts upon which management can act;
(*b*) provide as much information as is worth while;
(*c*) present the information in the best possible way;
(*d*) give adequate explanations of his figures.

The weakness of the commonly accepted or "orthodox" technique of costing is that the information is not presented in the best possible way, and detailed "explanations" must be given when comparisons are necessary between one line of action and an alternative.

The inclusion of fixed charges in the overheads included in costs makes it difficult:—

(*a*) to compare the effect of different courses of action;
(*b*) to measure the true efficiency of sections or departments;
(*c*) to fix selling prices so as to give the best results to that business as a whole.

When a business is commenced, its management decides that there is a demand for a certain commodity which is not satisfied, and considers that, if a factory is established to produce that commodity, it can produce adequate quantities of the approved quality at the right price, can pay wages which will at least maintain the standard of living of the type of worker required, and will leave a profit for enterprise. Having made this decision management proceeds to build or rent a factory, to install plant and machinery, to make jigs and tools, to appoint secretary, accountant, cost accountant, works manager, superintendents, and foremen, to equip the offices, and to advertise the products. All these things are done as a matter of policy, and the so-called "fixed costs," which appear in the first year's accounts, could well be designated "policy costs," and this term could be used for all those items which should be excluded from marginal costs.

The capital expenditure, and the costs automatically acquired by the business because of this expenditure (such as depreciation), together with such charges as have been mentioned, were incurred as a deliberate policy, to make profits over a long period, and any system of cost accountancy should reflect this. On the other hand "variable" or "out-of-pocket costs" are incurred, as production is carried out, and should vary practically in proportion to production.

As a matter of business policy therefore, management has two jobs:—

(*a*) *Over a Short Period:* to make sales *minus* marginal costs (which may be termed "contribution") as high as possible.

(*b*) *Over a Long Period:* to make sales *minus* total costs (*i.e.*, net profit) as high as possible.

Long-period policy has been considered before the business was commenced, and, unless management was convinced that, over a long period, a net profit would result, it is reasonable to assume that the business would not have been started. Having started business, the short-term policy must be considered, and management should attempt to make the contribution as high as possible, without, of course, forgetting long-term policy.

Where, as cost accountants, we are required to advise management upon the initiation of business ventures, we must consider both long- and short-period policy, but maximum consideration will of course be given to the long period: in the businesses with which we are connected the decision to produce has already been made and therefore maximum consideration is given to short-period policy: in both sets of circumstances the separation of out-of-pocket costs from policy costs is of paramount importance.

Under marginal costing systems we accept the position "as is," *i.e.*, we recognise the fact that the business is in a certain position at the present time, and show clearly what will be the effect of any action taken. This is not shown by any other system of costing, unless detailed and lengthy explanations support the costs.

PRACTICAL MARGINAL COSTING

The practical application of a system of marginal costing is no more difficult than is the working of any other system of costing, and it can be used with job, process or operating costs. The method of dealing with materials and labour is not affected: overheads alone are the problem, and even here there is little variation—merely an expansion of normal technique. The normal costing methods call for:—

(*a*) classification of all overheads under appropriate heads;
(*b*) collection of overheads actually incurred period by period;
(*c*) apportionment of overheads to production, selling, distribution, and administration;
(*d*) apportionment to departments, services, and producing units in the proportions in which it has been incurred;
(*e*) allocation to the products passing through the production departments on the appropriate bases, *e.g.*, as a percentage on labour, labour hour rate, or machine hour rate.

With marginal costing, changes start immediately: the classification in use may be sufficiently detailed, but if not it must be extended to separate the fixed costs from the variable costs, and it is here that the bulk of

trouble and disagreement will arise. If we think of policy costs and out-of-pocket costs and squarely face the position of our business as it is at the moment, we shall ultimately get this division. If management policy should be changed in the future we must face up to the position as it is; in other words our costs must always represent the facts as they are: *e.g.*, if management decides to scrap a battery of machines and do a job by hand (or *vice versa*) our costs must show this change, and separate policy costs from out-of-pocket-costs. What are fixed (or policy) costs will obviously vary to some extent from business to business, according to the policy adopted by management.

The collection of overheads actually incurred, period by period, will not differ under any system, but in the subsequent apportionments and allocations to products, the out-of-pocket or marginal overheads only are considered, in the first case.

The bases of apportionments and allocations are the same as under a normal system of costing, but, since fixed or policy overheads are excluded, the apportionment to departments, services, producing units, or cost centres, is likely to be more simple, and the allocation to products passing through the production departments, on the appropriate bases, will be more simple and more accurate. Under the usual methods of costing, normal annual overheads are spread over normal annual production, and periodically (usually each year but often at more frequent intervals) the cost accountant is required to compute rates of overhead recovery, based on these "normal" figures. Now there is no such thing as a static normal; conditions are constantly changing; and the opinion of general manager, works manager, departmental foreman, and cost accountant, or even of two cost accountants in the same business, are likely to differ widely in their assessment of normal. The result of this is that when we have applied our so-called normal overheads over normal production, and obtained a normal rate of overhead recovery, which has been applied to subsequent production, we always end our costing year with an over-recovery or under-recovery of overheads in all departments. This must be so, since any change in anticipated overheads or production will cause an error.

With marginal costing these errors are far less likely to arise, since we intend to recover over our production only those items which are incurred in the use of the production facilities, and therefore vary more or less in proportion to production. Anyone who, even with ordinary methods of overhead recovery, has investigated the reasons for variations in the recovery of overheads, cannot fail to have observed that marginal or out-of-pocket overheads really do keep step with production; they will agree that the computation of marginal overhead rates will be more simple and more accurate than the computation of total normal overheads including all the chargeable fixed or policy costs.

In the same way as marginal production overheads are considered, marginal costs of selling and distribution must be considered, and in these sections one cannot fail to recognise the ease of allocation, or the accuracy of the results, once fixed overheads are eliminated from the computation. Having carried out this procedure it is a simple matter to compile the marginal cost of any product with far more accuracy than the total cost can be compiled.

It is not suggested that fixed costs should be ignored; the cost accountant must certainly deal with these costs from the angle of control. Further, until both management and cost accountant have grasped all the significant features of the technique, it is probable that they will wish to see how the normal orthodox cost compares with marginal cost, for price-fixing purposes. From the control point of view a system of budgetary control is required, the budget being of a flexible type to take into account changes in the volume of production. This flexible budget is not inconsistent with the idea of fixed overheads if they are regarded as policy costs; thus up to a certain volume of production, a business can manage with its present equipment; at that stage it must—as a matter of policy—purchase more plant and machinery, which will increase its policy costs. Period by period the actual fixed overheads must be compared with the budget—and because the budget has been compiled as a matter of policy, management is easily able to compare the actual policy, as it is being carried out, with the board-room or "paper" policy. Control of the business as a whole is therefore exercised through standards for marginal costs, and by means of budgetary control for fixed or policy overheads, and the efficiency of all departments can be most readily seen, and illustrated, without extraneous matter, by these methods.

It is very simple to compile a normal cost from a marginal costing system.

Take the fixed overheads, so far omitted from the cost computations, and spread them over production, selling and distribution departments on the recognised bases, afterwards distributing these departmentalised charges to production and sales by means of the usual methods—man- or machine-hour rates for production overheads, or percentage on selling price for selling costs.

EXAMPLES OF APPLICATION

The most simple form of marginal costing would be applied in the case of a retail shop; figures for a year's trading for such a shop are as follows:—

	£	%
Sales	3,000	100.0
Cost of goods sold	2,000	66.7
Overheads (fixed)	750	25.0
Net profit	250	8.3

If this shop can, without the addition of any fixed overheads, sell another non-competitive product, but having a gross margin of 25 per cent only, and if it is estimated that sales amounting to $500 could be made in the succeeding year, under the marginal costing technique a budget could be drawn up as follows:—

	PRODUCT "A" (*At present sold*)		PRODUCT "B" (*Proposed to sell*)		TOTAL	
	£	%	£	%	£	%
Sales	3,000	100.0	500	100.0	3,500	100.0
Cost of goods sold	2,000	66.7	400	80.0	2,400	68.6
Contribution	1,000	33.3	100	20.0	1,100	31.4
Fixed charges	750	25.0	—	—	750	21.4
Net profit	250	8.3	100	20.0	350	10.0

If normal methods of spreading overheads over all sales had been adopted, it is probable that the information previously given would have been shown as follows:—

	PRODUCT "A" (*At present sold*)		PRODUCT "B" (*Proposed to sell*)		TOTAL	
	£	%	£	%	£	%
Sales	3,000	100.0	500	100.0	3,500	100.0
Cost of goods sold	2,000	66.7	400	80.0	2,400	68.6
Fixed charges	643	21.4	107	21.4	750	21.4
Net profit	357	11.9	—7	*1.4*	350	10.0

Now if the shop-keeper had been told—as the normal orthodox methods of costing would, at least, have implied—that the new line would result in a loss of £7, it is probable that it would not have been taken on, in spite of the fact that its introduction would add £100 to the net profit of the business.

If this affair can be imagined in reverse, *i.e.*, at the present time trade results are as shown in the last figures given, it is possible that the shop-keeper as a result of costs given to him, might decide to cut out the sale of the line on which £7 was lost. If he should so decide, the net result would be that his profit would fall by £100.

In this lies the danger of the commonly accepted methods of costing: unless our results are presented in such a manner as to indicate clearly the effect on costs of changes in volume of production, we are apt to mislead our managements. In the manufacturing business, our final trading account is the summary of thousands of costs, many no doubt showing net

profits, but some probably showing net losses. Only by the application of the marginal costing technique is one able to prove to management that by carrying out a job showing a net loss one adds to net profit.

The use of the marginal costing technique to decide whether to make or to buy is well known; from a cost point of view, one must compare the costs of production with fixed overheads eliminated, *i.e.*, marginal cost, with the cost to be paid to the supplier. Out-of-pocket cost is compared with out-of-pocket cost.

Although the technique is known to be of use when comparing the costs of different methods, it is doubtful whether all the lessons to be learnt from its use are known. To illustrate this the following example is submitted.

A job can be done on a power press at a labour cost of 4*d.* per gross, or on a hand press at 6*d.* per gross; normal rates of overhead recovery amount to 150 per cent on power press labour and 50 per cent on hand press labour. Ample material, presses, and jigs are available. Materials cost 4*d.* per gross. Shall the job be done on hand press or power press? After applying full overheads the power press job costs 1*s.* 2*d.* and the hand press job 1*s.* 1*d.*: but to get the correct picture marginal cost must be compared with marginal cost, when a quite different position will appear. If it is found that the marginal cost is 1*s.* in each case and the selling price is 1*s.* 3*d.*, which method should be used?

The "contribution" is 3*d.* per gross in each case. The power press operator, earning say 2*s.* per hour, does 6 gross an hour; the hand press operator, earning say 1*s.* 6*d.* per hour, does 3 gross an hour: the work done on the power press earns a contribution of 1*s.* 6*d.* per labour hour, the work on the hand press earns a contribution of 9*d.* per labour hour—so marginal costing would report. Normal costing would show power press work yielding a profit of 1*d.* per gross; hand press a profit of 2*d.* per gross—apparently double.

This problem can be set out clearly as follows:—

Hand press		*Power press*
3 gross	Production per hour . .	6 gross
4*d.* per gross	Material cost	4*d.* per gross
6*d.* " "	Piece-work price	4*d.* " "
3*d.* " " (50%) . . .	Full overheads (150%) . .	6*d.* " "
1/1 " "	Total cost	1/2 " "
1/3 " "	Selling price	1/3 " "
2*d.* " "	Apparent net profit . . .	1*d.* " "
2*d.* " " (33⅓%) . .	Marginal overheads (100%)	4*d.* " "
1/- " "	Marginal cost	1/- " "
1/3 " "	Selling price	1/3 " "
3*d.* " "	Contribution	3*d.* " "
3 × 3*d.* = 9*d.*	Contribution per hour . .	6 × 3*d.* = 1/6

THE KEY FACTOR OF PRODUCTION

In the last illustration, stress was laid on the contribution per hour, because in the statement of the problem it was said that ample material, presses, and jigs were available. Labour therefore is the "key factor" of production, and the volume of production is controlled by the number of labour-hours available: management consequently must seek to obtain the highest contribution per labour-hour, in order ultimately to reach the highest net profit.

The manner in which "contribution per key factor of production" is presented to management by marginal costing methods is certainly one of the most important reasons for its use. The key factor may be labour; it may be a certain class, type, or grade of labour; it may be materials, or a certain particular material; it may be an item of plant, or overhead facilities. The marginal costing technique alone shows clearly how the maximum net profit is achieved by obtaining the maximum contribution per unit of cost which is in short supply, i.e., per key factor of production.

The key factor in a business is worthy of study in some detail; it may vary from time to time in a business, and it may vary at a particular time as between two businesses in the same industry. In the tanning industry, owing to shortages of hides and labour at different times, the key factor has been the hide and the labour-hour respectively, but with ample supplies of hides and labour rapidly becoming available in this industry, it is likely to become a more normal factor—the pit-week. The marginal costing technique will be used to indicate to management the contribution made by each type of product per pit, per week (per pit-week). In the leather goods industry, in which machinery plays a relatively minor part, the key factor is usually the labour-hour, but at the present time production is controlled by the amount of leather granted to a manufacturer under licence, and consequently in certain sections of the industry management seeks maximum contribution per square foot of leather. In the engineering industry shortages of material, or of a particular type of material, of labour, or of a particular type or grade of labour, of machinery, or of a particular machine, or of space, may make each of these in turn the key factor of production, and with all except materials the time element must be combined. In the catering industry the key factor tends to be either materials or rationed materials, but in certain establishments the labour-hour or a particular type of labour-hour has at times been more important. With ample supplies of material and labour available, the key factor may change to the space-hour basis, or if ample space is available, to the customer-meal. In dairy farming the key factor may be per cow, but is ultimately likely to be per acre.

The importance of this varying factor has been, and is, recognised by most business men, but had not been given much attention by cost accountants, until the cost accountant operating the marginal technique clearly indicated how management could obtain the greatest contribution per key factor of production.

It has been said that "marginal costing obscures the demands of individual products on capital and other services represented by fixed expenses." Nothing could be more inaccurate. If capital, or any service, is the key factor of production in any business at any time, by marginal costing methods only can it clearly be shown, in a simple manner, and without lengthy and complicated explanations, how the best use can be made of that capital or service. But this must also be stated: in the majority of businesses operating on normal lines the key factor is likely to be a simple, every-day unit such as the square foot of leather, the labour-hour, or the pit-week, and consideration in the abstract of "capital and other services represented by fixed expenses" can well be left to theorists who have never tried practical marginal costing.

USE IN A BUSINESS

Within a business marginal costing has several definite contributions to make towards the solution of present-day problems; firstly, in presenting information to management at all levels. To the shop foreman there are given figures which he can influence by his action, the marginal or out-of-pocket costs. These can be presented in a simple way and are not complicated by the inclusion of fixed or policy costs, or obscured by the over-recovery or under-recovery of fixed costs. To the works manager there is given a statement of his marginal costs of production compared with his standard marginal costs, and a schedule of his fixed charges, compared with the budget for these charges which he assisted to draw up as a matter of policy. The sales manager receives similar information relating to selling activities, according to territories and types of product, and is able to see the contribution made by each area and product; then he can compare his actual fixed costs with his budget costs. General management, too, is given the results in two sections, and is able to compare marginal costs with standards in total and in detail, and the reasons for variations are stated simply and clearly. Further the fixed costs of the business are compared with the budget, and it is very easy for the cost accountant to indicate why these results were obtained. It is correspondingly easy for management, at all levels, to take any desirable and possible action to bring about the necessary changes.

Secondly, marginal costing enables management to formulate quick yet accurate decisions on matters of policy; whether to make or to buy;

whether to manufacture by this method or by that method; whether to produce this product or that product.

Thirdly, it enables management to make decisions on both long-term and short-term policy, since they are well informed of the position "as is," and are clearly guided by the costs and budgets regarding the effect of any action taken.

Fourthly, it enables management to achieve the maximum net profit during a period, by concentrating upon obtaining the maximum contribution per unit of the element of cost in short supply. In this connection, by focusing attention on the key factor of production, it ensures the most economic working of the business taking into account all factors.

Fifthly, in industries in which by-products arise, by its use the cost accountant is able to illustrate clearly the most economic method of dealing with a by-product.

Sixthly, if market research methods are sufficiently reliable that it is possible to estimate fairly accurately the volume of sales at varying price levels, it can be used for price fixing purposes to give the maximum contribution.

Lastly, in times of trade depression, it can be used to indicate to management the lowest price at which a sale can be made to recover out-of-pocket costs only. This aspect of the subject has been stressed so much that some cost accountants have regarded it as being the main if not the only object of marginal costing. The cost accountant who has operated such a system over the past ten years will certainly state that the first four contributions mentioned are much more important, and will probably express the view that the fourth has been most profitable.

65. DYNAMIC VARIABLE COST CONTROL

Fred G. Tuttle*

The author illustrates the steps to a comprehensive cost control report which emphasizes the controllable cost elements. He suggests that in the assembly of budget data the variable burden should be the residual element and not profit. The variable cost elements are especially stressed in a system of analysis and reports which incorporate an "ideal" concept.

* From *The Controller*, XXIV, 2 (1956), 62-65, 96. Reprinted by permission of *The Controller*.

American business today needs comprehensive cost control information to achieve desired net profit goals. It needs this information in a form which is readily understood and can be utilized effectively with a minimum of effort on the part of management and operating personnel. The needs of management and operating personnel may best be served by presenting them with a report in which the profit and loss chart, the budget, the forecast and the ideal cost concepts have been combined.

In modern American business the budget has become more a goal to be achieved rather than a forecast of "estimated income and expense." Therefore, in the comprehensive report the budget reflects the required income and costs to produce the desired net profit.

The concept of ideal cost, not found in most cost control programs, has been injected into the comprehensive program. Ideal cost might be compared to par on a golf course. Like a golfer, the businessman must constantly strive to lower his handicap to achieve par. Although he may never reach a perfect score, he must work to approach it to become or to remain successful in the highly competitive business world.

The budget is initiated by determining the desired annual sales, the per cent profit and the fixed expenses of the firm. It is assumed that the end-product (or products) are to be sold in a highly competitive market and therefore the estimated selling price per unit cannot be altered appreciably. If a new product is being introduced on the market, the selling price must be determined prior to the accumulation of actual costs.

In the established firm, fixed costs are determined by referring to historical records plus other considerations and estimates. The planners, in determining fixed costs, must also take into consideration what they will define as comprising the firm's nucleus. This nucleus is an important consideration since fixed expense is based on the premise that at zero volume the company will not be liquidated and that this central, "skeleton" group of key personnel will be maintained. The cost of maintaining this nucleus, plus depreciation, comprises the major portion of the firm's fixed burden.

Next to be determined are direct material and direct labor costs. Once again, historical data or estimated costs from which the selling price was set are available for reference. After deducting the above costs from the selling price, the remainder, or balance, is the variable burden. This variable burden is then allocated throughout the operating departments. This may in some cases prove to be a "tight squeeze," but if the desired profit is to be realized this allotment must not be exceeded. The only other course is to increase the selling price per unit, which cannot be done in a highly competitive market.

This procedure is illustrated by the accompanying profit and loss chart (EXHIBIT I) and explanation.

In this hypothetical situation, the desired annual sales have been set at $3 million, profit at 10% on sales or $300,000 and fixed expense at $600,000. By constructing the graph in the manner illustrated, the area below the line parallel to the total cost line represents the total variable cost. This is then easily determined to be $2 million. After drawing in the direct material and direct labor costs across the bottom of the graph, the remaining area represents the variable burden. Assuming direct material is budgeted at $700,000 and direct labor at $500,000, the total allowed variable burden is established at $900,000.

Up to this point operating management has not been consulted regarding their forecasted costs. Actually they would have been incapable of developing the above type of information. Since the budgeted fixed and variable expenses have been determined, should they now be requested to furnish such information? Actually they have been trained and possess the "know how" to get and maintain good production, therefore, it seems impractical to request them to spend the time forecasting their expenses for different volume levels.

Assuming for the moment that forecasts had been obtained and they exceeded the total allowed burden of $900,000, would they be accepted as submitted or would they have to be revised? Actually the figures would have to be revised if the profit objective is to be realized.

The departmental budgets, as prepared by the Financial Department, can be presented to the operating personnel at a meeting where the over-all plans and objectives of the firm are reviewed. In addition to the general review, specific information, pertaining to their departmental activity and its effect on the final objective, can be pointed out.

The next step in a cost control program of this kind is to determine the "measuring stick" or unit of production. This measuring stick reveals the cost per unit of production which plays a vital part in helping personnel achieve the desired net profit goals with a minimum of effort. It is of the utmost importance that the unit of measure, once established, not be changed during the period covered by the budget. A flexible measuring stick is of no value when it comes to measuring performance.

This measuring stick may be calibrated in practically any unit of measure, depending on the type of business. A laundry might use equivalent sheets as its unit of measure; another company might use pounds. Because of the variety of products manufactured in the average concern, standard hours of saleable production have proven to be a very satisfactory unit of measure. If the standards are set synthetically from carefully prepared basic data, a high degree of uniformity will be achieved. In the examples given here, the productive standard hour will

be used as the unit of measure. Productive standard hours will be referred to as standard hours in the remaining portion of this paper. Standard hours, however, are not a cure-all, since they can be misused as indicated in the typical monthly summary report (EXHIBIT II).

These figures indicate that February operations were poorer or equal to January and March in both variance and per cent of the budget. Although the figures are mathematically correct, the report nevertheless is misleading. The variable burden required to produce a standard hour of saleable production actually decreased each successive month.

If the fixed burden of $50,000 per month is subtracted from both the actual and budgeted expense and the balance divided by the standard hours produced, the resultant figures (EXHIBIT III) are definitely more informative.

These figures are not distorted due to the effect of volume variances on fixed expense. Actual variable expense per unit produced has definitely decreased each month. This important fact is hidden in EXHIBIT II. Moreover, personnel inspecting such a report would be seriously misled in interpreting the firm's operating cost for February in EXHIBIT II.

Since fixed burden is fixed for the budget period and does not vary with the volume, it should not be included in the "Variable Cost Control Report."

The dangers of including the fixed burden in reporting the cost per unit can be demonstrated in two short examples:

1. If a firm carries a fixed burden of $50,000 per month and produces 1,000 standard hours of saleable production at a variable burden rate of $8.00 per standard hour, then the cost rate per standard hour would be $58.00—by including the fixed burden in the calculations.

EXHIBIT I

PROFIT AND LOSS AND BREAKEVEN

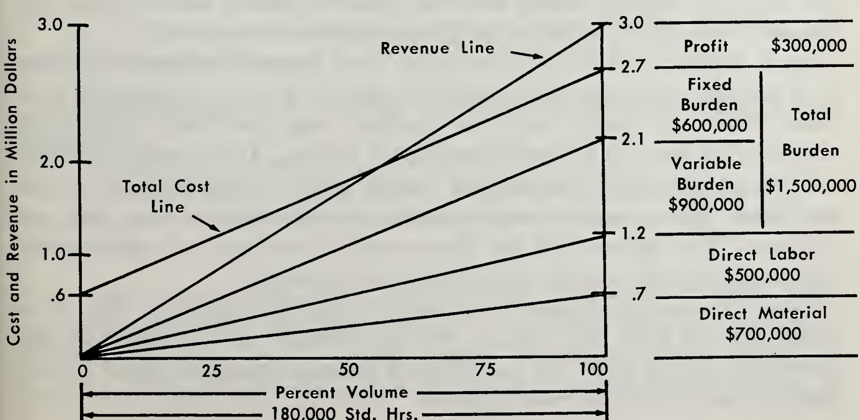

EXHIBIT II

	Production	Burden			
Month	*Standard Hours*	*Actual*	*Budget*	*Variance*	*Per Cent of Budget*
January	5,000	$ 80,000	$ 75,000	$5,000	106.7
February	10,000	107,500	100,000	7,500	107.5
March	15,000	132,500	125,000	7,500	106.0

EXHIBIT III

	Production	Variable Burden Per Std. Hour			
Month	*Standard Hours*	*Actual*	*Budget*	*Variance*	*Per Cent of Budget*
January	5,000	$6.00	$5.00	$1.00	120.0
February	10,000	5.75	5.00	.75	115.0
March	15,000	5.50	5.00	.50	110.0

$$\text{cost rate} = \frac{\text{fixed burden}}{\text{standard hours}} + \frac{\text{variable burden}}{\text{rate per std. hr.}}$$

2. Following the same line of thought, if the same firm, carrying the same fixed burden of $50,000, produces 5,000 standard hours of saleable production, but at a variable burden rate of $16.00 per standard hour, its cost rate per standard hour would be $26.00. At first glance this appears to be a reduction of more than half from the cost rate in the first example. The fallacy in this, however, is that the controllable cost per standard hour has actually doubled. With the fivefold increase in standard hours of saleable production, this amounts to an excess controllable cost increase of $40,000–[5,000 (16.00-8.00)].

Information of this nature is definitely misleading, therefore, not conducive to taking expedient corrective action.

With the fixed burden segregated and the use of a measuring stick (standard hours), a breakdown of cost elements by major groups may be made. Typical of such a breakdown is the information presented in EXHIBIT IV. It will be noted that the variable burden rate of $5.00 per standard hour agrees with the budgeted amount in EXHIBIT III.

As is evident in EXHIBIT IV the yearly fixed expense has been converted to a monthly basis and the variable budget to a cost per standard hour basis. Once the budget rates per standard hour have been established, they do not have to be recomputed each month. They remain constant for the budget period and do not change with varying volumes. It will be noted, the elements comprising the variable burden total $900,000 per year. This agrees with the figure earlier developed by the financial personnel from the over-all figures derived in EXHIBIT I.

Once the budget figures have been established, the next step is to determine the ideal cost. Earlier, the development of an ideal cost was mentioned, along with the fact that all variable costs are based on the standard hour of production produced.

A detailed study of each item of variable cost must be made to determine the optimum relationship between production and cost.

Such a study of direct labor costs indicates a rate of $2.00 per standard hour, as shown in EXHIBIT V. This is based on the average going rate of $2.00 per actual hour and the fact that the standard hour is based on an average man operating at 100% efficiency when producing a fair day's work.

The supervision and clerical group of accounts is based on the number of productive workers which one foreman and clerk should be able to handle. Other costs per standard hour are developed in the same manner. Comparative budget and ideal costs per standard hour are listed in EXHIBIT V.

It will be noticed that direct material has not been included in the above figures. Although it is a variable cost, material expenditure precedes production, therefore, it would have a tendency to distort the cost control figures during periods of increasing and decreasing production. Material expenditures can be controlled separately on an ideal cost basis.

Once all this information—the profit and loss chart, the budget, the forecast and the ideal cost—have been compiled, the financial personnel are ready to undertake the next and final step; preparation of a complete, comprehensive, combined cost control report.

This report, which presents the operating costs of the firm as a whole, is augmented by separate reports for each major cost center, e.g., administrative, sales, engineering, purchasing, manufacturing. These are, in turn, backed up by a budget report for each individual department.

A typical summary Variable Cost Control Report for the firm is presented in EXHIBIT VI. The lower portion of the report represents the operating costs for the current month. Variable cost per standard hour is determined by subtracting the fixed burden from the total reported costs and dividing the balance by the standard hours produced.

The information contained in EXHIBIT VI will immediately bring top management's attention to:

1. Forecasted profit or loss for the year based on current operating cost information.
2. The monthly volume in standard hours required to break even.
3. Per cent and excess variable cost per standard hour of budgeted goal.
4. A breakdown of variable costs per standard hour to quickly localize adverse trends.

An alert management, upon receiving the report for January 1955, would recognize the fact that the low volume rather than the budget variance accounted for the major portion of the loss. Excess costs due to variance from budget amounted to only $5,350, whereas the loss due to

EXHIBIT IV

	Yearly Budget			Monthly Budget	
		Variable			Variable
	Fixed	Total	Per Std. Hour	Fixed	Per Std. Hour
Standard Hours		180,000	—		
Direct Material		$ 700,000	$ 3.89	$ —	$ 3.89
Direct Labor		500,000	2.78	—	2.78
Burden					
Supervision and Clerical	$300,000	180,000	1.00	25,000	1.00
Material Handling	—	117,000	.65	—	.65
Supplies and Perishable Tools	—	81,000	.45	—	.45
Maintenance	72,000	108,000	.60	6,000	.60
Scrap	—	18,000	.10	—	.10
Other	228,000	396,000	2.20	19,000	2.20
Total Burden	$600,000	$ 900,000	$ 5.00	$50,000	$ 5.00
Total	$600,000	$2,100,000	$11.67	$50,000	$11.67
Less Direct Material	—	$ 700,000	$ 3.89	—	$ 3.89
Total Excluding Direct Material	$600,000	$1,400,000	$ 7.78	$50,000	$ 7.78

EXHIBIT V

	Variable Cost Per Std. Hour	
	Budget	Ideal Cost
Direct Labor	$2.78	$2.00
Burden		
Supervision and Clerical	1.00	.75
Material Handling	.65	.55
Supplies and Perishable Tools	.45	.40
Maintenance	.60	.45
Scrap	.10	.03
Other	2.20	1.82
Total	$5.00	$4.00
Total Variable	$7.78	$6.00

the low volume was $25,000. This total figure projected for the year would result in a loss of $364,200 as compared to the budgeted profit of $300,000.

Breakeven volume and profit or loss figures are computed as follows:

The yearly projected figure would then be the $30,350 loss multiplied by 12. Subsequent projected yearly profit or loss figures reflect previous months' actuals plus current month projected for the balance of the year.

Assume for a moment that EXHIBIT VI is the report for an individual operating department. EXHIBIT VI-A reflects the type of information that would appear in place of the information shown in the last five columns of EXHIBIT VI. Operating personnel, although interested in the profit and loss figures, could not use the information appearing in the last five columns of EXHIBIT VI to effectively control costs.

The information contained in EXHIBIT VI-A gives the operating person-

BREAKEVEN VOLUME—JANUARY 1955

Formula		
Sales Revenue = Variable Cost + Fixed Burden		
Sales Revenue per Standard Hour		
$\dfrac{\$3{,}000{,}000 \text{ Sales}}{180{,}000 \text{ Std. Hrs.}} =$		$ 16.67
Variable Cost per Standard Hour from report	$ 8.85	
Direct Material Cost per Std. Hr.		
$\dfrac{700{,}000}{180{,}000} =$	$ 3.89	$ 12.74
Fixed expense per month		$ 50,000

Let x = Standard hours required to breakeven
Then January breakeven volume is:

$$16.67\,x = 12.74\,x + 50{,}000$$
$$3.93\,x = 50{,}000$$
$$x = 12{,}723 \text{ standard hours}$$

Profit or Loss—January 1955		
Equivalent Sales Produced		
5,000 Std. Hrs. @ $16.67 =		$ 83,350
Less Cost		
Variable		
Direct Labor & Burden		
5,000 Std. Hrs. @ $8.85	$44,250	
Direct Material		
5,000 Std. Hrs. @ $3.89	19,450	
Fixed Burden	50,000	113,700
Monthly Profit or (Loss)		$(30,350)

EXHIBIT VI—VARIABLE COST CONTROL REPORT

Monthly Fixed Cost	—	25,000	—	—	6,000	—	19,000	50,000	
	VARIABLE COSTS PER STANDARD HOUR								
Period	Direct Labor	Supervision and Clerical	Material Handling	Supplies and Perishable Tools	Maintenance	Scrap	Other	Total Variable Burden	Total Variable Cost
Budget	$2.78	$1.00	$ .65	$.45	$.60	$.10	$2.20	$5.00	$7.78
Ideal	2.00	.75	.55	.40	.45	.03	1.82	4.00	6.00
1955 Actual									
January	2.85	1.20	1.45	.60	.45	.15	2.15	6.00	8.85
February	2.50	1.10	1.35	.40	.70	.10	2.10	5.75	8.25
March	2.35	1.15	.95	.50	.65	.05	2.20	5.50	7.85
April	2.40	1.05	1.10	.25	.55	.10	2.15	5.20	7.60
May	2.20	1.15	1.10	.40	.60	.30	2.10	5.65	7.85
June	2.30	1.05	1.15	.10	.55	.10	2.15	5.10	7.40

EXHIBIT VI (*Continued*)

Standard Hours Produced	Per Cent of Total Variable Cost Budget	Monthly Volume Required to Break Even — Standard Hours	Monthly Profit or (Loss) Contributable to — Budget Variance	Monthly Profit or (Loss) Contributable to — Volume	Monthly Profit or (Loss) — Total	Yearly Projection — Profit (Loss)
15,000	100	10,000	—	25,000	25,000	300,000
15,000	77	7,375	26,700	25,000	51,700	620,400
5,000	114	12,723	(5,350)	(25,000)	(30,350)	(364,200)
10,000	106	11,038	(4,700)	—	(4,700)	(82,050)
15,000	101	10,142	(1,050)	25,000	23,950	204,450
16,000	98	9,653	2,880	30,000	32,880	284,820
14,000	101	10,142	(980)	20,000	19,020	173,940
15,000	95	9,294	5,700	25,000	30,700	255,700

EXHIBIT VI-A

Per Cent of Anticipated Volume	Variance (Over) Under — Budget	Variance (Over) Under — Ideal
100	—	—
100	—	—
33	(5,350)	(14,250)
67	(4,700)	(22,500)
100	(1,050)	(27,750)
107	2,880	(25,600)
93	(980)	(25,900)
100	5,700	(21,000)

nel a direct comparison of monthly controllable costs as compared with the budget and the total dollar variance caused by his individual efforts.

A summary of the salient features embodied in the dynamic variable cost control program are:—

1. Budget is definitely tied in with the profit objective.
2. Management is immediately aware of the effect the cost and volume variance will have on the final net profit if current conditions prevail for the balance of the year.
3. Operating personnel can tell at a glance to what extent their individual efforts have been effective.
4. Positive cost control information is readily available for all volumes of operation with a minimum amount of effort.
5. Forecasting budget allowances for succeeding month or months has been eliminated. Costs automatically reflect the actuals for the volume produced.

6. Variable cost information is reported as cost per unit of production. This information is readily understood by non-financial personnel. The figures in themselves show up the reasonableness of the costs.

7. Controllable cost figures are not distorted by the inclusion of fixed expense.

8. All costs per unit of production are directly comparable regardless of volume changes.

9. Once the report has been established, positive information is available to determine effects on costs under certain conditions; for example, what effect would there be on costs if material handling were arbitrarily cut in half or a preventive maintenance program were instituted? If the all-important cost per unit of production is lowered, the desired objective is being approached.

10. Areas requiring cost analysis are highlighted on the variable cost report. Great stress is usually placed on increasing the direct labor efficiency. The month of June indicates an excess cost, over ideal of $0.30 per standard hour for direct labor. More money, however, is being lost through inefficient material handling with an excess cost, over ideal, of $0.60 per standard hour.

11. With an inflexible unit of measure basic information is established for the development of a sound estimating system.

12. Operating personnel has not been burdened with forecasting budget allowances that in all probability would not conform to the predetermined figure established by the financial men.

Combining of the profit and loss chart budget and ideal cost with the actual operating costs in one single comprehensive report supplies management with simple and direct information upon which to reaffirm or revise operating policies.

66. THE VALUES AND USES OF DISTRIBUTION COST ANALYSIS

American Marketing Association
Committee on Distribution Costs and Efficiency
Dr. Donald R. Longman, Chairman*

The article reviews the present route of distribution cost analysis, suggests improvements, and discusses means of expanding its use and validity in the future.

* From the *Journal of Marketing*, XXI, 4 (April, 1957), 395-400. Reprinted by permission of the *Journal of Marketing*, published quarterly by The American Marketing Association, and Donald R. Longman, Chairman of the Committee on Distribution Costs and Efficiency, *American Marketing Association.*

THE ROLE OF DISTRIBUTION COST ANALYSIS

As the total production of goods and services has expanded in the United States, our distribution system has become increasingly complicated. For this reason, distribution costs have tended to rise, and the achievement of greater distribution efficiency has become an increasingly important objective for more and more forward-looking companies.

When a company succeeds in increasing its distribution efficiency, it is able to make more goods available to more people at lower prices. Increased efficiency on the part of one company, therefore, puts pressure on its competitors to improve their distribution operations. By helping individual companies to increase their distribution efficiency, distribution cost analysis helps to promote a sounder economy under our free enterprise system.

DEFINITION OF DISTRIBUTION COST ANALYSIS

Distribution cost analysis is the assembling of the various items of distribution cost into meaningful classifications and their comparison in this form with alternative expenditures and with related sales volumes and gross margin. More specifically, it is a technique used by individual business concerns for the determination of the costs of performing specific marketing activities and for the determination of costs and profits for various segments of the business such as products or product groups, customer classes, or units of sale—and a study of these findings in the light of possible alternatives.

THE VALUES AND USE OF DISTRIBUTION COST ANALYSIS

Distribution cost analysis may be used by businessmen as an aid in determining profitable objectives for the business, in setting policies and procedures of operation, in determining the efficiency of their organization, and in measuring the profitability of operation in individual segments of the business.

More specifically, distribution cost analysis may be used:

1. To determine the kinds and amounts of expense incurred in each separate marketing activity such as outside selling, billing, warehousing, and delivery.

Availability of such cost data permits effective assignment of responsibility for cost performance to specific individuals supervising the activities. They

make it possible also to trace the reasons for changes in cost over a period of time or variations in cost from budget, and the detailed record provides a basis for corrective action. They open the way to development of standard costs where standards are feasible.

2. To evaluate marketing methods, policies, and operating procedures.
Distribution cost analysis provides basic data for appraising the value of services (such as credit or delivery), methods of sale (by telephone, mail, or personal solicitation), and company performance of functions as opposed to use of outside organizations (for delivery, warehousing, and the like). It facilitates judgment as to when and where agents, distributors, or other middlemen will be more economical than direct sale.

3. To determine the marketing cost and profitability of the company's various products or customers.
Cost analysis permits calculation of these facts for individual products and customers or for such groups of them as product lines, brands, styles and sizes, classes of trade, sales territories, and the like. Such data are useful, too, in estimating costs and profits for proposed products or for changes in product or customer mix.

4. To determine the relationship between cost and order size—as a basis for diminishing losses on small orders and as a basis for quantity-discount schedules conforming to the Robinson-Patman Act.

Any general use of distribution cost analysis by businessmen for the appraisal of marketing structure, policy, and plans would have significant economic implications. The effect would be to increase the general level of marketing efficiency. Competition, in turn, may be expected to transfer much of the economy gained to the public through lower prices. Thus, widespread use of distribution cost analysis would be the equivalent of a general technological advance in industry. The reduction in unit costs and increase in efficiency from use of distribution cost analysis may be even greater than that attained as a result of the pioneer work in time and motion studies and cost accounting in the factory.

THE METHODS OF DISTRIBUTION COST ANALYSIS

There are two basic steps in distribution cost analysis: (1) the determination of the cost of performing each distribution activity or function of the business and (2) the determination of the costs of these functions which are associated with products, customers, territories, or other segments of the business.

FUNCTIONAL COST DETERMINATION

This step requires first a detailed analysis and listing of the many distinct marketing activities carried on by the business. Because com-

panies vary widely in the kinds of marketing work done, the lists of activities will vary greatly from company to company. Each company must prepare its own list of activities on the basis of a careful study of the exact work done.

Cost records must then be set up in such a manner that all direct and indirect costs incurred for each separate activity are identified. Some costs are incurred simultaneously for two or more activities. In such cases it is necessary to apportion the jointly incurred cost to the individual activities. This can be done by means of time study, space measurements, counts, managerial estimates, and other methods. It is most expeditious, economical, and accurate to determine functional costs currently as part of the ordinary accounting process, but it is possible to determine these costs at a later date.

A functional classification of marketing costs has a number of advantages even though the analysis proceeds no further. A functional classification of marketing costs reflects and parallels the organization of the business and the responsibilities for expenditure. Accordingly, a functional classification facilitates control of marketing expenditures. (The classification of costs by function permits attainment of the first two objectives listed under Values and Uses of Distribution Cost Analysis above.)

DETERMINATION OF COSTS FOR SEGMENTS OF THE BUSINESS

The many marketing activities of a business are undertaken to permit handling and sale of the company's various products to its various customers in its various territories. There is thus a direct relationship (in most cases) between the scale and cost of each activity or function and certain characteristics of the products handled and the customers served. The second step thus involves determining just what these relationships are and expressing them quantitatively.

A knowledge and measurement of these direct relationships between functional costs and characteristics of products handled or customers served permit allocation of an appropriate share of each activity's cost to individual products and customers and other segments of the business. When this is done for all costs, it is possible to determine the total marketing costs attributable to specific products and customers. Thus, after costs have been classified by activities or functions, they are allocated on the basis of utilization by products, customers, and other segments of sales of the activities giving rise to these costs. For each functional-cost group, an allocation factor must be selected which can

serve as a measure of the portion of that cost which is properly applicable to each segment of sales. The procedure followed is to charge the product or customer (or other segment of sales) with the cost of its share of the activity of each functional-cost group; that is, the cost of the portion of the marketing effort for which it is "responsible."

Some analysts hold that it is not useful to charge any cost to a specific product or customer unless there is a clear causative relationship between the product or customer characteristic and the cost total. They point out that functional-cost groups vary in the extent to which they can be directly associated with products or customer characteristics. They say that these costs cannot be charged to individual products or customers but must be treated as overhead. The question still remains, however, as to the method of absorbing overhead by each segment of sales. If all overhead is not absorbed, it will not be possible to show net profits by products or customer classes. Without these net profit figures, it is difficult to make full application of the results to management decisions.

Management use of these cost figures begins with a comparison of totals and of the detailed cost patterns of handling the various products and customers. Such a study is still more valuable if total gross margins for each product and customer are determined. Total costs may then be subtracted from gross margins to reveal net profits or losses.

Profit results for individual customers may be added together to show profits by sales territory, by channel of distribution, by customer size, or other groupings. Similarly, product profit results may be added together to show profits by brand, by price line, by style, or other product groupings.

Analysis of the data presented for products and customers and other segments of sales discloses basic reasons underlying profit or loss results and suggests types of corrective action. These may include efforts at expansion or contraction of certain products or of sales to certain customers or substitution of some products or customer classes for others. They may also involve proposals to eliminate classes of business. The latter proposals must be studied in the light of the short-run and long-run variability of the costs incurred in handling this business as shown by the detail of costs charged to it.

Measurement of relative profitability of segments of sales, based on a determination of costs associated with these segments, can help management to resolve marketing-oriented problems involving a choice between alternative decisions.

POSSIBILITIES OF USE: LIMITATIONS

A technique still relatively new, as is distribution cost analysis, always has far more opportunities for use than have been realized. That it is not used at all by some firms, and is used by others only infrequently as a special research project, is due for the most part to this newness. In part, however, it is due to natural limitations.

Certain conditions should exist in order for the values and uses of distribution cost analysis to be realized. Some degree of specialization of personnel *or* some variety of products *or* some complexity of operation must exist, for otherwise costs come in lumps that cannot be broken apart satisfactorily. Specialization and complexity are not necessarily closely correlated with the size of the operation. Some opportunity to change operating policies or procedures must exist so that facts uncovered can be utilized successfully. Some realization by management of the need or benefit of cost control or functional control or standard costs is needed to support and utilize the analysis. In addition, some understanding of the techniques of cost analysis and ability to interpret results are necessary conditions.

Another important limitation and variable is the available accounting data. Although even a rudimentary accounting system can provide the basis for a study, the cost tends to be higher, and accuracy—though still acceptable—suffers. Accounting procedures should provide details on sales, cost of sales, and gross margin, which permit classification by products, customers, and salesmen. Allocation data—such as number of orders, salesmen calls, and invoice lines and value of average inventory—also are best provided by regular accounting procedures, not by special, supplementary studies. Current accumulation of expenditures into functional-cost groups not only facilitates cost studies but also provides improved cost control. Decisions must be made as to whether, and how much of, the gathering of sales analysis and allocation data shall be a part of regular accounting processes (either manual or machine) or will be gathered "after the fact" and at infrequent intervals. Practical decision also must be made as to use of simplified methods or more detailed methods which yield maximum accuracy. A great deal of flexibility exists on this score within the limits of useful and practical results.

The amount of detailed calculations required for formal cost analysis makes it a forbidding task for firms without an adequate analytical staff. This limitation may soon be removed by the potentialities of the new electronic computers. The actual computations of even a major cost

analysis would take only a few hours on one of the large computers now available for hire. In the future, the role of the distribution cost analyst may be limited to specifying the data to be collected, programming the computer for handling these data, and interpreting the results.

THE STATUS OF DISTRIBUTION COST ANALYSIS AND REQUIREMENTS FOR ITS FURTHER DEVELOPMENT

The rapid development of distribution cost analysis during the past thirty years reflects the growing interest of business management in the problems of measuring and controlling marketing costs and efficiency. This interest has been sparked by the increasing complexity of our national distribution system and the resulting pressures on individual companies to improve their distribution efficiency to maintain profit margins.

The methods of distribution cost analysis have now been developed to a point where most of the major problems in the field can be soundly approached when existing techniques of analysis are properly applied. As distribution grows more complex, and as further research is completed, new and improved methods will undoubtedly be developed. Methodology, however, is no longer a factor that seriously restricts expansion of the field.

Rather, growth in the use of distribution cost analysis seems to hinge primarily on the number of personnel who are qualified to make skillful use of existing distribution cost analysis techniques. The opportunities for this application appear to be expanding faster than the number of trained personnel. This poses the question—what steps should be taken to overcome the present shortage of trained personnel?

To this end, it is suggested that collegiate instruction in distribution cost analysis be substantially increased, both at the undergraduate and graduate levels.

It is further suggested that trade and professional associations interested in the field of business administration place greater emphasis on distribution cost analysis in their programs. Printed literature based on the resulting articles, speeches, and discussion sessions will not only serve to broaden the interest of business personnel generally in the subject but will also help to increase the quality of the instruction received by students.

Finally, it is suggested that marketing and accounting people make an effort to become more fully conversant with the mutual problems they have in developing and applying distribution cost figures. Marketing men too often are inadequately informed concerning the principles, practices, and problems in accounting which underlie cost records. On the other hand, accountants too often are ill-informed on the practical problems of marketing and the assistance which accounting can render in solving them.

One final point . . . government recognition of the validity of distribution cost analysis as a basis for developing admissible evidence in litigation will help to increase the stature of the field and broaden still further the application of distribution cost analysis.

67. TENTATIVE STATEMENT OF COST CONCEPTS UNDERLYING REPORTS FOR MANAGEMENT PURPOSES

The 1955 Committee on Cost Concepts and Standards
American Accounting Association*

The article describes the field of accounting within a framework sufficiently broad to provide an insight into the problems of providing information for management purposes. In this context the concept of the word cost is not limited to that which is usually associated with cost accounting.

Explanatory Note: The concepts set forth in this statement are not standards for the cost accounting procedures of recording historical cost. They represent concepts of the costs most useful to management for planning and control decisions. It is to be expected that in practical application, various techniques, procedures, and rules will be developed, of which historical cost recording is but one, to provide data representative of the costs suggested by these concepts. Often the representations of the basic costs will be rough approximations of varying degrees of reliability. The basic concepts of cost described in this statement serve two functions: First, they indicate desired measures of cost and thus serve as a basis for judging the reliability of any cost data provided to management for planning and control decisions. Second, they serve as an inducement to the development of improved techniques and procedures for supplying appropriate cost information to management.

The development of techniques and procedures to provide the most reliable approximations of the basic costs is beyond the scope of this statement. Such procedures and techniques may be expected to differ from enterprise to enterprise but the basic concepts of cost set forth here are the underlying concepts toward the realization of which the specific techniques and procedures strive. The basic concepts are believed to have rather general application.

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PREFATORY NOTE

In June, 1936, the executive committee of the American Accounting Association issued a tentative statement of accounting principles underlying corporate financial statements. That statement and subsequent revisions suggested concepts and standards underlying the preparation of accounting reports on financial position and income. While reports of income and financial position are used by managements in reaching certain broad decisions, a far greater proportion of managerial decisions and actions are based upon other reports. This suggests the need for a statement of the concepts underlying these other reports.

For several years, work has been proceeding toward the development of a statement of cost concepts useful in the preparation of reports for management. Progress in this area has now reached a point where it seems desirable to issue a tentative statement of such cost concepts. This statement seems advisable to advance the following objectives:

1. To stimulate further study and discussion of the accounting information needed by management.
2. To suggest cost data which are pertinent to various types of management problems.
3. To call attention to the broad and indefinite nature of cost as a general term and to reveal how appropriate costs depend upon the purpose for which they are to be used.
4. To describe a portion of the field of accounting within a framework sufficiently broad to provide an insight into the problem of providing accounting information for management purposes.

The concepts set forth here represent a broad approach to the problem of business cost. As such they include concepts generally not appropriate for the determination of income and include costs which may not be a part of the basic accounting records. Essentially they suggest the most appropriate cost data for management uses. In this report attention is directed toward the development of underlying concepts. These concepts, in turn, may require further development of procedures and working approximations to effect their application in any given business situations.

THE NATURE OF BUSINESS COST

For business purposes, cost is a general term for a measured amount of value purposefully released or to be released in the acquisition or creation of economic resources, either tangible or intangible. Normally it is measured in terms of a monetary sacrifice involved. There is, however, nothing to prevent its measurement in other terms nor to prevent the adjustment of monetary sacrifices to common units of purchasing power. Conceptually, cost excludes distribution of capital and income as well as certain unexpected value releases.

Basic Framework—An understanding of the nature of cost requires comprehension of (a) the purposeful aspect of the term "cost," (b) the relationship of business risk to cost, and (c) methods of measuring value releases.

(a) To qualify as cost, the value release must be for the purpose of furthering a managerial objective. There are two aspects to this concept. First, only the value releases necessary for the acquisition or creation of economic resources to carry out a managerial objective are costs. Second, the amount released will depend upon the use to be made by management of the computed costs. Thus the cost of acquiring or creating economic resources for a managerial objective should include only those value releases necessary to carry out the specific objective. But, because the purpose in measuring the value releases may be to aid management in varying levels of planning and control decisions, the amount of value release will depend upon the use to be made of the computed costs. In somewhat comprehensive terms, the purposeful aspect of cost means that because managerial objectives vary both in scope of activity (ranging from over-all activities to a multitude of minor activities) and in the nature of the management function being performed (ranging from planning to control), the value releases to be included in any cost report will vary with the situation of the firm as well as with the specific objective of management. In a broad sense, this recognizes that the cost of anything will depend upon the purpose for determining cost.

(b) Business operations necessarily involve risk. In some instances these risks are transferred to an insuror. In others, though not transferred, they are measured and allowed for as an element of cost. In still others, they cannot be foreseen or, if foreseen, are so uncertain that estimation is impractical. Value releases occasioned by the transfer of risk to an insuror, or by uninsured risk which lend themselves to measurement, are costs. Value releases occasioned by unforeseen, or highly uncertain, risks are not costs but should be considered in evaluating the risk of the operation. If incurred they are, of course, considered as losses in determining income.

(c) Normally, value releases due to operations are measured in monetary terms. The measurement of the monetary sacrifice involved in the acquisition or creation of economic resources is simplest when the value release is an outflow of cash. Adjustment for the timing of cash outflow is sometimes necessary and can be accomplished by discounting or advancing outflows at an appropriate rate of interest. Similarly, adjustment for changes in the purchasing power of money can be made by the use of appropriate price indexes. The needs of management for a report on monetary sacrifice, however, often require the measurement of noncash outflows. Most often such outflows result from the release of economic

resources now on hand. It is in the measurement of these latter outflows that special difficulties arise.

Cost Classifications—Cost is classified normally in terms of a managerial objective. Its presentation normally requires sub-classification. Such sub-classification may be according to functional lines, areas of responsibility, the nature of the cost elements, or some other useful breakdown. The appropriate sub-classification depends upon the uses to be made of the cost report.

Uses of Business Cost Reports—Within the foregoing framework of the nature of cost, various concepts may be developed that are appropriate in the preparation of cost reports useful for business decisions.

Managerial functions may be grouped into the areas of (1) planning and (2) control. Cost concepts appropriate for each of these two areas are developed in this statement. In general, the cost concepts useful for planning are those relevant to a managerial decision on future action; whereas the cost concepts useful for control are those which aid in carrying out adopted plans. In addition, because the costs in accounting records are used by management as a basis for planning and control, it is advisable to set forth certain concepts which underlie these accounting costs. Accordingly, this statement deals with cost concepts appropriate for planning and for control, and with historical cost reports to management. The concepts set forth are somewhat ideal. Approximations of these basic concepts often must be used in business situations.

COSTS FOR PLANNING

Depending upon the purpose for which it is undertaken, all business planning may be classified as (1) project planning or (2) period planning. Project planning is the process whereby management, confronted by a specific problem, evaluates each alternative in order to arrive at a decision as to the course of future action.[1] Period planning is the process whereby management systematically develops an acceptable set of plans for the total future activities of the enterprise, or some functional subdivision thereof, for a specified period of time.

The two types of planning can and often do occur simultaneously. While some of the more important problems requiring project planning are apt to occur sporadically and involve alternatives of long and vary-

[1] In a broad sense project planning may be defined as the process of reaching a decision on future action. It may range from the least important decision of the least important worker to the broadest of decisions by the board of directors. As a process it may be described as (a) recognizing several possible courses of future action, (b) evaluating each alternative (in both monetary and non-monetary terms), and (c) expressing a decision to adopt one of the alternatives as the course of future action. Planning costs are concerned primarily with the evaluation process.

ing time periods, others follow the fixed time pattern of period planning. The second situation exists because management is able to control the length of time for which alternative commitments may be made, and chooses to employ the period planning cycle as that length of time. For this reason many activities entailed in the process of period planning are actually project planning. Wherever a selection between alternatives is necessary, project planning is involved.

COSTS FOR PROJECT PLANNING

Costs for project planning are estimates of future value releases anticipated as a result of adopting any one of the alternative courses of future action considered by the company. Such costs are future costs which may be expressed as differential costs because evaluation is a comparative process requiring the determination of how total costs (and revenues) are likely to vary under different sets of future conditions.[2]

In estimating future differential costs of each of a given set of alternatives, it is necessary to recognize one alternative as the standard. Often this standard is the alternative which envisages mere continuation of the current plan. All services[3] required by each of the other alternatives which differ as to type, quantity, or time of release from those required by the standard must be determined and their future costs estimated.

In order to measure the future costs of these differential services, a distinction should be made between differential services on hand, or for which the company is irrevocably committed, at the beginning of the planning period, and those to be acquired within that period; between those expected to be entirely consumed within that period and those of which a residual is expected to remain at the end of the period; and between those which management considers replacing and those which it does not.

Furthermore, when the project planning period is long, it is necessary to adjust all differential costs in order to take account of significant

[2] Any alternative may be analyzed by determining the total expected value release occasioned by all future activities of which it is but a part and comparing this cost with the total costs of other alternatives, determined in the same manner. Since many costs are common to every alternative, the comparison actually rests on the differences in total costs of the alternatives. In this "Tentative Statement of Cost Concepts" the more direct procedure is stressed. Only differential costs of the alternatives are to be measured and compared. The difference between the two methods is procedural, but care must be taken in the direct approach to ensure that important differences are not overlooked. There is less chance of making this kind of an error if the total cost procedure is used.

[3] The term "services" is sometimes used in a more narrow sense to refer to personal services but there seems no sound reason to restrict the term when it is evident that the purchase of either labor or physical assets is for the purpose of acquiring the services in these resources.

time and risk variations. The most satisfactory method for doing this is by means of the discounting procedure.

Differential Services to be Acquired and Fully Consumed—The basis for estimating future costs of differential services to be acquired and fully consumed within the planning period is the expected future outlay of cash, or its equivalent, required for their acquisition.

1. When the cash outlay is expected to coincide with service acquisition and both will take place over a period of time, the proper measure of cost is the sum of the discounted amounts of (a) the initial outlay, (b) the complementary outlays required for realization of the initial outlay, and (c) any further outlay required to dispose of the acquisition.

2. Often the outlay will be in the form of a promise to pay cash, or its equivalent, at a time subsequent to the service acquisition date. In this situation the value release as of the date of expected service acquisition should be measured by discounting the expected cash outlay to the date of service acquisition. A rate of interest equivalent to that required for borrowing money may be used for the discounting process. The resulting amount should be treated as in (1) above.

3. At times the outlay will be in the form of services other than cash, or promises to pay cash. If replacement of such services is considered, the cash equivalent is measured by their estimated replacement cost, at the time of expected replacement discounted to the date of acquisitions. If replacement is not considered, cash equivalent is measured by the estimated net proceeds foregone (i.e., net selling price adjusted for estimated selling costs) because of the exchange.[4] The resulting amount should be treated as in (1) above.

Differential Services to be Acquired and Partially Consumed—The basis for estimating future costs of differential services to be acquired and partially consumed during the project planning period is the future outlay of cash, or its equivalent, required for their acquisition, less the estimated cash equivalent valuation of services remaining at the end of the period.

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[4] The concept employed here is frequently called value in best alternative use. Where replacement is considered, the value in best alternative use is presumed to be a substitute for the cost of replacement. If the time period between the date of exchange and the date of expected replacement is long and storage costs are important, replacement cost at the time of expected replacement should be adjusted by the estimated differential storage costs saved through the proposed exchange.

If replacement is not considered, net proceeds is the higher of the remaining alternatives of: (1) sale as is; or (2) use in some other production or distribution activity. In the latter case, the value cannot exceed replacement cost.

Throughout this entire section, it is presumed that management's consideration of replacement reflects the fact that it is the best alternative. That is, it considers replacement only where the discounted replacement cost is in excess of net proceeds. If this assumption were dropped, the proper measure of cost would be discounted replacement cost or net proceeds whichever is the higher.

1. The measure of the cash, or its equivalent, for the acquisition of these services is the same as that used in measuring differential services acquired and fully consumed.
2. If replacement of the remaining services is considered by management, their valuation can be measured by estimated replacement cost, at the time of expected replacement, discounted to the end of the period.
3. If replacement of these residual services is not a present consideration, their valuation may be measured by estimated net proceeds as of the end of the period.

Differential Services on Hand and Fully Consumed—The basis for estimating future costs of differential services on hand, or for which the company is irrevocably committed, at the beginning of the period which are expected to be fully consumed within that period is their cash equivalent valuation at the time of utilization.

1. If replacement of such services is considered by management, their valuation is estimated replacement cost at the time of utilization.
2. If replacement of such services is not a consideration of management, their valuation is estimated net proceeds foregone at the time of utilization.

Differential Services on Hand and Partially Consumed—The basis for estimating future costs of differential services on hand, or for which the firm is irrevocably committed, at the beginning of the period which are expected to be partially consumed within that period is their cash equivalent valuation at the time of utilization.

1. If replacement of such services is considered, their valuation is estimated replacement cost, at the date of expected replacement, discounted to the time of utilization.

Time, Risk and Uncertainty Adjustments—The future differential costs associated with each alternative must be adjusted for time, risk of loss, and uncertainty of risk before evaluation is possible. Discounting each anticipated future cost to some common point in time is usually the most satisfactory method of adjustment for time and risk factors. The rate(s) of discount used for these purposes should reflect management's appraisal of the risk entailed by each prospective undertaking.

If the time periods of two or more of the alternatives are significantly different, these differences must be taken into account in any calculation. One method of doing so is to compare the two alternatives on the basis of the rates of return implied by their respective investments and future net proceeds.

Another method is to select a common time period, preferably the shortest period, to which the firm would be committed by the adoption of any one of the alternatives. Each of the longer alternatives can then be fitted to the shortest period by estimating the cash equivalent valuation of the residual services as of the end of the common time period.

The degree of uncertainty attending each of the estimates of future differential cost for each of the various alternatives may be taken into account by employing different rates of discount, or setting forth a range for each set of estimates. Full disclosure of the bases for the estimates should be made to assist management in its evaluation.

Pricing—A special area of planning which warrants separate attention is pricing. Cost is one element in the determination of price, but it must be considered in concert with numerous other factors embodied in the total concept of demand.

In non-repetitive sales, the future differential cost of making and selling the product, measured from the costs of not making and selling the product, ordinarily establishes a lower limit for price. This limit may be ignored by management for short periods because of certain non-monetary factors, but the monetary sacrifice entailed in so doing is measured by the difference between price and future differential cost. It is management's responsibility to determine subjectively whether or not this sacrifice is warranted by non-monetary considerations.

In repetitive selling, many non-monetary factors such as competitive reactions, legal requirements, or ultimate needs for replacement, usually dictate a higher minimum than that embodied in any short period planning cost. Conceptually, the planning costs for pricing goods which are sold repetitively should take into account the discounted total future gains and losses occasioned by the adoption of any one price or price structure rather than another. Since most of these future gains and losses defy satisfactory expression in monetary terms, the selection of the margin of price over future differential costs is a direct responsibility of management.

COSTS FOR PERIOD PLANNING

The principal objective of period planning is the development of various sets of plans and their conversion into a single over-all plan in order to direct and coordinate each of the separate activities and to assure that their summation is an acceptable whole. The period adopted usually is one year. The adopted plan is the basis for communication and includes cost data useful for control of subsequent operations.

Period planning usually results in an over-all budget. Such planning ordinarily is carried on within the framework of anticipated costs and revenues for income determination purposes or other rather complete accumulations of costs rather than differential cost constructions. In this respect period planning represents a potential area of conflict between planning and income determination costs. For those activities whose future service requirements within the budget period will be consumed during the same period, the period planning employs essentially the same

cost concepts as project planning. One difference is that for convenience project plans are often measured in terms of differential costs whereas period plans are stated in terms of rather complete accumulations of cost. In those activities for which services are on hand at the beginning or end of the planning period, the results of the two also may differ because period planning uses the booked cost valuations for income determination as opposed to the cost concepts appropriate for project planning purposes.

In many instances project planning is carried out as a part of period planning. In other instances, it is not feasible to subject all areas of the business at short intervals to a review and replanning of past adopted plans or to undergo project planning for all items. These latter items then enter into the planning process directly via period planning.

Normally, the process of period planning involves a build-up of estimated future costs by areas of responsibility and functions which must be performed if major policies and previously adopted plans are to be followed. Typically, the estimating procedure utilizes historical costs. The concept of variable cost is a useful device for such planning purposes, but it can be easily misinterpreted. Because it normally reflects the relationship of only one variable (volume) to the behavior of total costs, this concept is often inadequate, since expected changes in factors other than volume (e.g., price, efficiency, or management attitude) will have a significant effect upon future outlays. Variable cost may be used as a first approximation of future cost. Adjustments can be made to take account of expected changes in the other variable before final estimates are determined.

Period planning provides for an over-all evaluation by top level management of a master plan prepared in accordance with major policies and restrictions previously imposed by it. It is constructed as a reviewing device rather than as a means of providing the basis for the preparation of another master plan or revision of the plan under consideration. Changes in planned combinations of activities, induced by apparently unsatisfactory total results presented in period planning, should be re-examined in the light of the proper concepts of project planning cost before they are effected.

The communication of adopted period plans normally envisions their construction in such a manner as to co-ordinate and control the activities of the firm. This involves the assignment of these period plans to areas of responsibility.

COSTS FOR CONTROL

Cost data are useful in the control of current operations. The selection of cost concepts for such purposes is a matter of personal discretion depending upon the cost construction which in the given situation is believed to be best able to accomplish the objectives. Therefore, such costs

may be historical costs, standard costs, planning costs, or even constructions which merely simulate costs. They are useful for three main purposes:

1. Costs are useful, along with other devices, as a means of communicating information about approved plans.
2. Costs may be constructed and used in a way that will motivate individuals within the organization to take action most likely to further the interests of the firm.
3. Costs are useful as a means of reporting actual performance and the difference between actual performance and the performance that should have been attained under the circumstances. These reports may provide a useful tool for improving performance in future periods.

Costs as a Communication Device—Cost data help to convey information about the objectives that management wishes to achieve, the methods to be used to achieve these objectives, and the limitations to which the organization is expected to adhere. These objectives, methods, and limitations are the result of decisions reached in the planning process. Cost data therefore are devices by means of which management can direct individuals within the organization to carry out plans. In this use, costs may be classified in terms of activity, personal responsibility, or types of services to be used in carrying out the adopted plans. While the budget is one form of communicating information of this type, it is, of course, not the sole means and rarely is it as important as other communication devices, particularly oral instructions.

The measurable concepts of cost appropriate for the communication function require a mutual understanding by management and individuals of the bases upon which the costs are calculated.

Costs as a Device for Motivation—Cost data, if properly constructed and if accompanied by proper management action and attitude, can be an important factor in motivating the organization, for they may serve as an incentive for accomplishing the planned objectives. Some concepts useful in developing cost data that help to motivate individuals within the organization may be suggested.

1. A basic concept of motivation is that it is best accomplished when costs are related to personal responsibility, but this does not mean that individuals should be charged only with costs for which they are completely responsible. There are few, if any, elements of cost that are the sole responsibility of one person. Some guides in deciding the appropriate costs to be charged to a person (responsibility center) are as follows:

(a) If the person has authority over both the acquisition and the use of the services, he should be charged with the cost of such services.

(b) If the person can significantly influence the amount of cost through his own action, he may be charged with such costs.

(c) Even if the person cannot significantly influence the amount of cost

through his own direct action, he may be charged with those elements with which the management desires him to be concerned so that he will help to influence those who are responsible.

2. A method of motivation that may be useful is the designation of a cost limit to serve as a restriction on service acquisition or utilization for a specified activity. This approach is especially useful in areas where costs cannot be related to specific performance, such as research personnel, and other staff functions.

(a) The limitation may represent an inviolate ceiling or merely a statement of expectations around which a certain amount of latitude is permitted.

(b) The limitation may be expressed as a single amount or it may be broken down into detailed service categories depending upon the type of control that management wishes to exercise.

3. The basis of measurement used in providing cost data for control is often a matter of management discretion and an important consideration in motivation. Different bases may significantly affect the way in which different individuals are motivated. For this reason, the bases of measurement selected should be consistent with the type of motivation desired. For example, different types of motivation may result when maintenance costs are charged to a responsibility center on the bases of: (1) a rate per maintenance labor hour, (2) a rate per job, or (3) a single amount per month.

4. Reporting with respect to costs for which any person is held responsible should be consistent both as to basis for measuring any given cost factor and the types of cost factors included in such reports. This implies that if a budget includes labor costs measured on a standard basis, performance costs being compared with the budget should be measured according to the same standard. Likewise a person should not be held responsible for a cost factor in one report, and be freed from responsibility for the same factor in another report.

Costs as an Appraisal Device—Costs for control purposes are prepared (1) before the fact (in the form of standard, or budgets) and (2) after the fact (in the form of performance reports). Actually, control can be achieved only before the fact. Nothing that happens after the fact can in any way alter or undo what has already been done. The appraisal process that is based on performance reports is useful only insofar as it leads to better performance in the future, by instigating a study to avoid repeating previous mistakes. In addition, knowledge of the fact that an appraisal is to be made can be an important stimulus to good performance on the part of the person being judged. The performance reports used in the appraisal process are both a device for motivating individuals and a means of conveying information to management useful in starting a new planning cycle.

Some concepts underlying the construction of a cost reporting system are:

1. The concept of a standard. Costs can be set forth as a standard against which actual performance is to be measured. A standard cost is a statement of expected costs, or what costs should be under an assumed set of conditions. There are various types of standards. Normally they are predetermined costs and serve both the communication and motivation control functions. They may be expressed as average product costs and as functional or area of responsibility costs in such forms as "normal capacity" costs, "ideal" costs, "current attainable" costs, and "budgeted" costs. When the standard is in terms of specific responsibilities within the firm, it may be classified in varying degrees of detail depending upon the degree of control management desires to exercise. For close control a detailed classification is appropriate so that variations of all types are reportable to management. If close control is not desired, in order to encourage employee initiative, or if not possible, because of the nature of the activity, a broad classification of standards covering longer periods of time or broader area of activity, is appropriate.

2. The equity concept. The person being appraised should understand the basis on which performance is being judged and accept it as an equitable base.

3. The exception concept. Effective reports ordinarily are designed so that attention is focused on areas where performance cost differ significantly from standards.

4. The frequency with which costs are reported depends on the time interval within which significant departures from standards may occur, the cost of reporting, and on the time required to take corrective action.

While the foregoing comments are primarily applicable to subdivisions of the enterprise, there is a quantitative measure especially useful in appraising over-all performance of the organization. This measure is the rate of return on investment. The standard against which the return may be compared is the rate of return which might have been earned if the investment were in another enterprise of comparable risk. This is often approximated by the return earned by other companies in the same industry or by other divisions in the same company.

From the foregoing, it should be apparent that no objective, universal definitions can be made for costs used for control. Since costs are constructed in accordance with the motivation desired, they are necessarily subjective, and it follows that "objective truth" has no relevance as a concept in the area of control. This does not imply intentional dishonesty or trickery, any more than do the principles of semantics. It does mean that there cannot be a single, objective definition of costs for control purposes.

HISTORICAL COST REPORTS FOR PLANNING AND CONTROL

The previous sections on planning and control have set forth basic concepts appropriate for cost reports for management. The implementation of these concepts in cost reports rests on varying degrees of reliability. As a result, many firms use the data available in the conventional accounting system as a basis for planning and control decisions. It is appropriate therefore that a statement be prepared indicative of the concepts underlying such cost reports for planning and control. It must be recognized that these concepts are approximations of the more basic concepts previously set forth. In this statement, only those concepts at variance with or supplementary to the concepts underlying corporate reports to stockholder are presented.

1. Assets, exclusive of cash and direct claims to cash, are bundles of services and cost accounting is concerned with the acquisition, utilization, and disposition of services.

2. Acquisition cost is the cash or cash equivalent released, on the acquisition date, to acquire services but there is no reason to assume that every service has an acquisition cost attached to it.

a. Normally, interest is not recorded as a cost of non-monetary services acquired but is treated separately as a cost of money. This should not preclude the treatment of minor elements of interest as cost when its separation is difficult and involved.

b. For some purposes (such as a status report on firm investments as an aid in future planning) recognition in memorandum accounts may be granted services to be acquired on the date the order is placed. For most purposes, however, recognition in accounting records may be delayed until the acquisition of the services.

c. Services acquired should be classified in a manner which facilitates their tracing on subsequent use. Because management normally plans in terms of types of physical units and changes these plans frequently, the most useful basic classification is in accordance with the form containing the services. Other classifications may supplement this basic classification to reveal intended use and assigned responsibility.

3. Utilization Cost is a measure of the cost of the services used in a specific period of time. There are two aspects of this problem: (1) measuring the services used, and (2) assigning a cost to the services used.

a. In measuring the services used, the following classification is often helpful:

(1) The services expiring due to the passage of time alone.

(2) The services which would have been consumed by the passage of time, but were in fact used in the operation process.

(3) The services used solely because of the operation process.

(4) The services which preclude reasonable determination of the time of their use and must be treated conventionally, such as types of advertising.

b. The services used in any period of time should be measured first in terms of a portion of the acquisition cost (according to some assumed flow) to the firm. Ideally, such a measure should reflect the intent of management.

For example, if a higher price were paid for some of the services in an asset (as might be the case in the first year's services of a machine or building), the measures of the services used should reflect such managerial intent. If specific intent is not known either by management or the accountant, it seems desirable to reflect the typical use of asset services and measure them in the following manner.

(1) Services used as acquired (such as labor and utilities) but paid for at regular intervals may be costed as though every service had the same cost within the pay period. This should not, however, preclude the more accurate procedure of costing according to individual measures of services used when the amount involved is important or significant and the information is avaliable, as is the case of labor under piece rate pay.

(2) Services which attach to physical units and flow with them (such as materials and supplies) may be costed at the average cost of each unit in individual bundle purchases or at the average cost of each unit for all bundle purchases in a period of time. When a different average is computed for each bundle purchase, any flow of sequence in which the bundles are used may be assumed. Consistent use of one adopted flow becomes important if management is to understand resulting reports.

(3) Services which flow from physical units without any flow of physical units (such as depreciation) may be costed on the assumption that services flow with output and cost assigned as an equal amount per unit of output. Or, the assumption may be made that services flow with the passage of time and services used may then be costed to periods of time either in equal amounts per unit of time or according to some other method of apportionment.

(4) Services whose time of utilization is difficult to determine, such as advertising and administrative salaries, ideally should be set up as assets acquired and treated as utilization cost on some reasonable basis representative of the effort applied through the use of such services. This basic conception, however, should not preclude the general view that such services are used as acquired provided there is no basis for the more satisfactory treatment.

c. In addition to the measurement of services used in terms of acquisition cost, it is sometimes helpful to measure the use of these services in terms of replacement cost[5] so as to provide a separation of the gain or loss due to non-operational factors from the operating gain or loss.

(1) It may be useful to separate general price level gains or losses from specific price level gains or losses.

(2) As services acquired at no cost or at significantly less than fair market value are used they may be measured in terms of replacement cost and the resulting gain separated from other gains.

4. Activity cost is a measure of the cost of the services used in performing some function, such as creating a product or some activity in the process of doing so. Any allocation of costs involves approximations. When allocations are to be made, such as for product costing, they may be measured in terms of utilization costs and may be separated between those due exclusively to the

[5] Replacement cost is used here as the cash or cash equivalent currently required to replace the services used, not necessarily the physical unit. Also it is conceived in terms of the normal method of purchasing, which involves bundle purchases of services. Replacement cost is thus a share of the cost of replacing the bundle of services which normally will be purchased. The allocable share should be measured in a manner similar to that used in determining the share of acquisition cost used.

operating process and those which would have been consumed with the passage of time if not used. In some cases it may be possible to allocate services used in a period of time according to one over-all basis. In other cases each element of cost may be assigned according to some physical unit representative of the flow of the services. In still other cases where there is no feasible way of allocating costs according to the flow of services, any reasonable basis of allocation may be used.[6]

5. Disposition costs are a measure of the services disposed of during a period of time and are useful in income reports to management. Frequently it is desirable to separate such costs between those whose services were originally used solely because of the operating activity from those whose services were related to the passage of time. Normally they are measured in terms of acquisition costs, but it is sometimes desirable to separate acquisition costs into the two elements of utilization costs and variations of utilization costs from acquisition costs.

a. The cost of services traced to units of products should not be considered disposed of until the product is sold or otherwise relinquished.

b. Services used in operations but not assigned to products should be separately classified in income reports unless there are reasons to defer them. Such reasons relate to the intent of management at the time of their use and the extent to which they are expected to aid in providing revenue in subsequent periods.

COSTS FOR EXTERNAL PURPOSES

Financial Statements—Costs are, of course, an important consideration in the measurement of income and in the valuation of assets for purposes of financial statements prepared for stockholders and other outside parties. Cost concepts relevant for these purposes are included in the statements on "Concepts and Standards Underlying Corporate Financial Statements" prepared by the Committee on Accounting Concepts and Standards of the American Accounting Association, and therefore are outside the scope of the work of the present committee.

Cost-Type Contracts—Many contractual agreements specify that payment be made on the basis of cost or of cost plus an allowance for profit. In view of the fact that no generally agreed upon definition of "costs" exists, it is important that the parties to the contract define in considerable detail what they mean by "cost" in the particular situation to which the contract applies.

Even though care is taken in framing this definition, it is unlikely that all problems that will arise can be foreseen. Most of these problems pertain to the treatment of "common costs"; that is, costs that relate partly to the work being done under the contract in question and partly to other work done by the enterprise. A case in point is the occupancy costs of a building in which both work under the contract and other work are being performed during the same time period. When the contract itself

[6] There should be no assumption that only manufacturing overhead should be assigned as a cost of product.

does not specify how these costs are to be divided, the division should be made in terms of conventionally accepted accounting procedures. To the extent that conventionally accepted accounting procedure do not provide a solution, the appropriate allocation may be made by references to arbitration or to courts of law.

There seems to be a belief in some quarters that there is, or should be, some scientifically correct way of dividing these costs. This belief is incorrect. Although there are generally recognized customs or conventions that may be helpful in certain areas, none of these has, or can have, the status of scientifically valid rules since common costs are, by definition, not precisely identifiable with one specific contract or project.

68. DIRECT COSTING

Alphonse Riverin*

The author sets forth in a concise manner the elements of the direct costing method, including the advantages and disadvantages of such methodology.

Business growth has created complex administrative problems. To face them administrators need more information in a form they are able to understand. Management's essential task is to make decisions in every phase of business transactions.

Cost accountants have developed systems that provide management with some information, usually timely and useful but frequently little understood by administrators. Absorption costing has long been the only way accountants thought information should be conveyed. However, for many years now, another system, called direct costing, has been adopted to an increasing extent.

This system for providing cost information has created antagonism among those who support the more traditional method.

WHAT DIRECT COSTING IS

First, it has to be stated that the procedures used in conjunction with direct costing do not convey the meaning usually attached to direct costs. In cost accounting direct costs are the costs directly identified with the

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* From *The Canadian Chartered Accountant*, LXXI, 4 (1957), 345-50. Reprinted by permission of the Canadian Institute of Chartered Accountants.

product, such as direct labour and direct material. All other costs are called overhead or manufacturing expenses. The cost of the product, under absorption costing, includes direct material, direct labour and overhead.

Under direct costing all the variable manufacturing costs (direct and indirect) are included in the cost of the product, all other costs being considered as period costs and charged off currently to profit and loss instead of to cost of sales. However, selling and administrative expenses are not included in the cost of sales, and consequently in inventories are taken into account before arriving at what is called the marginal income. Therefore, the method would be better described as variable costing.

The essential difference between absorption costing and direct costing is that the first emphasizes the distinction between production costs and all other costs whereas the second emphasizes the distinction between fixed costs and variable costs. Absorption tends to stress inventory valuation whereas direct costing is primarily interested in cost analysis.

In EXHIBIT 1, an example has been set up showing the differences in profits arising out of the two methods. From the study of this exhibit, the following inferences can be made:

1. When sales and production are the same, there is no difference in profits.
2. When production is lower than sales, profits are higher under direct costing because there is no fixed overhead coming from inventory charged to cost of sales.
3. When production is higher than sales, profits are higher under absorption costing because of fixed overhead having been carried to inventory.
4. When sales are constant and production varies, the direct costing method shows a gross profit ratio more constant.
5. Variances in profits due to any one method tend to zero in the long run. Production and sales can vary over short periods, but a business can never sell more than it produces.

POSITIONS OF PROFESSIONAL BODIES

Direct costing is not yet used in a sufficient number of companies to be called a generally accepted principle of accounting.

Moreover, accounting associations have not yet given official recognition to this new convention. In bulletin No. 43, which superseded all its previous bulletins, the American Institute of Certified Public Accountants did not speak of direct costing as such, and the bulletin is not very clear as to the position adopted. In the chapter on inventory pricing, Statement No. 3 reads: ". . . cost means in principle the sum of the applicable expenditures and charges directly or indirectly incurred in bringing an article to its existing condition and location." But in the following paragraph, it is stated; ". . . general and administrative expenses should be included as period charges, except for the portion of such expenses that

may be clearly related to production and thus constitute a part of inventory costs. Selling expenses constitute no part of inventory costs." Yet it is further stated: "It should also be recognized that the exclusion of all overheads from inventory costs does not constitute an accepted accounting procedure." This last sentence leaves an open door to direct costing. If it is not proper to exclude all overheads from inventory costs, it might be proper to exclude only fixed costs.

On the other hand, the American Accounting Association adheres strictly to the cost principle in its statement on Accounting Concepts and Standards Underlying Corporate Financial Statements: "Adherence to the cost basis of accounting requires that there should be no suppression or unwarranted assignment to expense of the costs of existing assets."

EXHIBIT I

	1953	1954	1955	1956
Production	5,000	3,000	4,000	5,000
Units sold	5,000	5,000	3,000	6,000
Variable manufacturing cost (unit)	$ 1.50	$ 1.50	$ 1.50	$ 1.50
Variable selling and administrative costs	.50	.50	.50	.50
Fixed manufacturing costs	1.00	1.00	1.00	1.00
Selling price	5.00	5.00	5.00	5.00
Total fixed costs	5,000.00	5,000.00	5,000.00	5,000.00
Fixed selling administrative expenses	2,000.00	2,000.00	2,000.00	2,000.00

PROFIT AND LOSS STATEMENT

	1953	1954	1955	1956
Absorption Costing				
Sales	$25,000	$25,000	$15,000	$30,000
Cost of sales	12,500	12,500	7,500	15,000
	$ 2,500	$12,500	$ 7,500	$15,000
Unabsorbed overhead		2,000	1,000	
Gross profit	$12,500	$10,500	$ 6,500	$15,000
Fixed and variable general expenses	4,500	4,500	3,500	5,000
Net income before taxes	$ 8,000	$ 6,000	$ 3,000	$10,000
Direct Costing				
Sales	$25,000	$25,000	$15,000	$30,000
Variable manufacturing costs	7,000	7,500	4,500	9,000
	$17,500	$17,500	$10,500	$21,000
Variable general expenses	2,500	2,500	1,500	3,000
Marginal income	$15,000	$15,000	$ 9,000	$18,000
Fixed manufacturing costs	5,000	5,000	5,000	5,000
	$10,000	$10,000	$ 4,000	$13,000
Fixed general expenses	2,000	2,000	2,000	2,000
	$ 8,000	$ 8,000	$ 2,000	$11,000

In its Research Bulletin No. 5, The Canadian Institute of Chartered Accountants seems to recognize the two methods. In effect, it says, the

cost of finished goods in inventory includes the price of raw material, direct labour and usually the share of overhead that can be traceable to production. On the other hand, the Institute recognizes implicitly direct costing when it states that in some cases it is proper not to include fixed overhead if its inclusion would impair the significance of the profit figure due to fluctuations in the volume of production.

From the positions taken by professional associations, it can be seen that no agreement has been reached. It should be noted, however, that practising accountants seem almost ready to accept the direct costing method in view of its practicability and simplicity.

ADVANTAGES OF DIRECT COSTING

Direct costing has been devised to produce useful statements more easily understood by management. It shows clearly, without requiring any additional work, the cost-volume-profit relationship. Hence by looking over the report, management sees the effect of production and sales variances on profits. As the profit figure is not influenced by the fixed costs which must be incurred whether the facilities are producing at full capacity or not, direct costing makes administrators more conscious of the importance of costs. It also reveals the influence of fixed costs on net profit before taxation.

Once all variable costs (variable manufacturing, selling and administrative costs) have been deducted from net sales, the remainder is the contribution of operations to fixed costs and profits. This figure, usually called marginal income, is very useful to management. When it is expressed as a percentage of sales, it gives the marginal income ratio which allows the computation of the break-even point by dividing fixed costs by this ratio. This essential computation brings to light the sales figure above which the firm is building profit and under which it paves the way to failure.

Moreover, direct costing supplies the data needed by management in profit planning, make-or-buy decisions, pricing decisions, and decisions relating to capital expenditures, whether for replacement, cost reduction or expansion.

Any item which covers part of overhead increases the net profit of the firm. All products do not contribute equally to profits. Thus when information is given in detail by departments and by products, eliminating the fixed costs from the computation, it allows management to make decisions as to what item is more profitable, what lines should be promoted and to what extent a non-profitable item can contribute to fixed costs. Hence pricing is facilitated and selective selling can be made. Undoubtedly, absorption costing could give the same information, but with much more clerical work, since its procedures are not directed to that end.

Due to proper classification of expenses, it is possible to place responsibility for variable and fixed costs control. Fixed costs are no longer classified by departments or function but by item of expenses.

Cost information should not be more expensive than the value of its service to management. By developing cost information only when it is useful, direct costing has the advantage of simplicity and economy.

Inventory valuation derived from direct costing does not always comply with generally accepted accounting principles. However, because of its usefulness for internal reporting, it should not be an insurmountable problem for external reporting. To bring inventory into conformity with accepted practice, the procedure is to add or subtract from the inventory figure obtained by direct costing the amount of fixed costs that would otherwise have been taken into account under absorption costing.

To take this step is to resort in large measure to what absorption costing does, except that in direct costing it is done probably once a year, while in absorption costing it occurs constantly.

DISADVANTAGES OF DIRECT COSTING

The most difficult problem in direct costing seems to be the classification of costs as variable or fixed. Even in practice some costs that pertain to the cost of production are classified as periodic costs due to the complication resulting from their allocation to products. A good example would be discounts on purchases which are often classified as period costs because of the difficulty of assigning them to the proper batch of raw material.

Variable and fixed costs are classified by the following principle: fixed costs are those providing the capacity to produce and expiring with the passage of time, regardless of extent to which the facilities are actually utilized. All other costs traceable to products are considered to be variable costs because if there was no production, such expenses would not have been incurred.

Consequently, fixed expenses are treated as profit-reduction items, not as value-creating items. This position is quite objectionable since if there were not any facilities to produce, there would not be any production at all. Facilities are used to create values, not reduce profits.

Moreover, some expenses usually considered fixed are sometimes variable, whereas other expenses ordinarily classified as variable are fixed. For example, the depreciation charge takes into account wear and tear of the facilities and their obsolescence. Only the latter can be said to expire with the passage of time. The first is due to the use of facilities. Consequently it is as variable as direct material or direct labour.

In some companies a large part of direct labour is fixed and will not vary with production volume. This is usually true of the highly-skilled

groups of workers. Whether or not to separate these expenses into variable and fixed depends upon the proportion that the costs bear to the total cost of production.

In its essence, direct costing is an application, at the accounting level, of the traditional marginal analysis which may be stated this way: marginal cost is attained at the level of output where the incremental unit cost (traditionally presumed to increase as output increases) is equal to the price per unit which may be obtained for that output.

The conclusions reached by marginal analysis as to price policy and output are applicable only to short run analysis and are valid only in the short run. Obviously, a firm that would take into consideration only variable cost in pricing its products would gradually consume its investment in long life assets and cease to exist as a going concern. Consequently, even if variable and differential costs are important for short run decisions, management cannot ignore the aggregate costs in planning the future strategy of the business.

It is often advanced that management must strive to maximize profits in the short run. However, nowadays another motivating force of management is the desire to assure the continued existence of the business with reasonable profits.

As previously mentioned, direct costing understates the value of inventory for reporting purposes. In the balance sheet, the working capital ratio is thus understated. This situation might create some problems for credit purposes.

Finally, direct costing when first adopted prohibits comparison with any prior year, unless a good deal of extra work is done to change the past periods to a direct costing basis. There is also the lack of comparison with other firms in the same industry which have not adopted the direct costing method.

69. DIRECT COSTING*

Research Series No. 23 on "Direct Costing" issued by the National Association of Cost Accountants in April, 1953, is a classic in the subject. Excerpts are presented to give a brief history of the subject and the advantages of direct costing over absorption costing.

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* From Research Series No. 23, issued by the National Association of Cost Accountants, April, 1953. Reprinted by permission of the National Association of Accountants.

DEFINITION OF DIRECT COSTING

Direct costing applies to cost accounting statements the same principles of cost-volume-profit relationship which are illustrated by the break-even chart. The essential characteristics of direct costing have been stated as follows by Neikirk:

> "Direct costing should be defined as segregation of manufacturing costs between those which are fixed and those which vary directly with volume. Only the prime costs plus variable factory costs are used to value inventory and cost of sales. The remaining factory expenses are charged off currently to profit and loss. However, the point to be emphasized is that direct costing is primarily a segregation of expenses and only secondarily a method of inventory valuation. By this approach, full attention can be devoted to the effect which direct costing has on the profit and loss statement and supplementary operation reports."

HISTORY OF DIRECT COSTING

The earliest published description of direct costing discovered in this study was written by Jonathan N. Harris, and was published in the *N.A.C.A. Bulletin* for January 15, 1936. Application of the term "direct costing" to describe the method was also made for the first time in this article. Mr. Harris' company began using direct costing two years before the above article appeared, and a few other companies interviewed in the field study started earlier. In one of these companies, the budget director had installed a cost system in 1908 which provided for accumulating fixed and variable costs separately in order that marginal cost data would be available for pricing. The same plan was subsequently used in several other companies with which the same individual became associated and it was introduced in 1919 by one of the companies participating in this study. However, this company has continued to use absorption costing in arriving at inventory costs. Another company has costed inventories at direct cost consistently since organization of the company in 1922. One company interviewed changed from absorption costing to direct costing in 1926 and another started a gradual changeover in 1932.

In seeking ways to develop better information about cost-profit-volume relationships, the direct costing approach appears to have occurred to a number of industrial accountants who worked independently in developing their ideas. Direct costing has had a parallel development in Great Britain during the same years. There is also some evidence to indicate that the method is used in continental European countries, although differences in language and accounting terminology made it impossible to determine the extent of its use there.

MANAGEMENT'S NEED FOR DIRECT COSTING

An understanding of the relationships between costs, volume, and profits enables management to choose its objectives on a more realistic basis and to make decisions with greater assurance that objectives will be reached. Consequently, the development of factual information about the behavior of costs and profits under conditions of changing volume and effective presentation of this information is an area in which the industrial accountant has an opportunity to make an important contribution.

Since cost and sales income figures constitute the basic data for cost-volume-profit analyses, some accountants decided that it would be advantageous to redesign cost and income statements to show key cost-volume-profit relationship figures within the statements themselves. This was accomplished by first deducting variable costs from sales income to arrive at marginal income and then deducting fixed costs to arrive at net profit. In addition, the chart of accounts was modified to permit separate accumulation of fixed and variable costs in the accounts. Statements in the desired form could then be prepared directly from the books rather than by analysis of balances taken from accounts in which fixed and variable cost components were mixed together. This plan of accounting is commonly called "direct costing" in the United States and "marginal costing" in Great Britain.

In discussion, direct costing is usually presented as an alternative to "absorption costing." The latter term is used to cover any of the various methods whereby fixed manufacturing costs are applied to production and included in inventories. The significant characteristic of absorption costing is that fixed and variable production costs are merged in charges to the same accounts. In contrast, direct costing maintains the separate identity of fixed and variable costs in the accounts.

DIRECT COSTS AND DIRECT COSTING

The term "direct costing" seems to have originated in the practice of defining inventoriable product cost as the sum of those manufacturing costs which are related to production in the sense that they vary directly and proportionately with volume. This usage of the word "direct" differs from another common accounting usage which applies the same term to costs which are assigned to products by direct charging in contrast to costs which are assigned to products by allocation. In practice, those who use direct costing include variable manufacturing overhead as part of the direct manufacturing cost even though these costs are, as a practical matter, assigned by allocation. For purposes other than costing inventory, variable nonmanufacturing costs are also classified as direct product costs by these who use direct costing.

MARGINAL INCOME

When variable costs are deducted from sales income, the resulting figure is usually called marginal income. When dealing with individual products or other segments of total sales volume, the marginal income from a given segment measures the amount which that segment has contributed toward fixed costs and profits taken as a whole. For this reason, the term "contribution margin" is often used synonymously with marginal income. Other terms such as "marginal balance," "profit contribution," and "variable gross margin" are also used in practice for the same purpose.

Where direct costing is in use, marginal income replaces the gross margin figure on the income statement. Separate marginal income figures are often calculated by successive deduction of the several functional classes of variable cost. For example, a margin may be shown after variable manufacturing costs and a gain after variable selling costs. In addition, some companies break down fixed costs into two classes, viz., (1) fixed costs that can be specifically identified with and charged to individual product classifications and (2) fixed costs that are joint as to the various product classifications.

The first group contains items such as depreciation, property taxes, insurance and other costs of equipment used solely to produce a single product or class of products. Product advertising and sales promotion can also be charged directly to the individual product in many instances. In several field interviews, it was stated that many of these fixed costs could be eliminated if the product should be dropped.

The second group of fixed costs contain fixed costs which are joint as to the individual product classes shown on the company's commodity income statement. Among the costs here included are fixed charges on buildings and equipment used to manufacture several different products, fixed general factory and company administrative costs, and fixed selling costs where these are joint as to the various products.

PRODUCT SELECTION AND EMPHASIS

Some typical questions which arise together with examples showing applications of direct costing are given below.

1. Which products should be emphasized in order to obtain a more profitable sales mix? Marginal income tells how much each product is contributing to fixed costs and profits in the present sales mix. Therefore management know which items will add the most to profits if sales of these can be increased. Profits will also be increased if sales of any items showing a negative contribution to fixed costs can be decreased. Continued acceptance of business where selling price does not cover variable cost may, of course, be justifiable where the unprofitable items are ex-

pected to reach a profitable status in the future or where the unprofitable goods help sell other things that are profitable. With marginal income figures available, management knows the cost of such policies and is in a position to weigh advantages against the costs.

In making decisions with respect to comparative desirability of products, it is necessary to measure the marginal income ratio in terms of the factor which limits the company's capacity to produce and sell. One company calls this the "effective contribution margin." For example, a company can produce either product A or product B on customers' special orders, but limited capacity makes it impossible to accept both orders. If product A yields $1.00 in marginal income per hour of plant capacity while product B yields $1.25, it will obviously be advantageous to accept the order for B. Another variation was reported by two companies which found production limited by shortages of an essential raw material. These companies chose for continued production those products which contributed the largest margin per pound of scarce material.[1]

Where available capacity exceeds the current volume of sales, profits will be increased by taking any business which carries a positive marginal income even though absorption costing would show that this contribution does not cover the fixed costs allocated to the product or order. In addition, most companies have some products which show little or no net profit, although they make some contribution to fixed costs. So long as the volume which these products provide cannot be replaced with more profitable business, the company's total profit benefits by continuing to sell the "unprofitable" items. In such decisions, marginal income figures eliminate any confusion as to what the questioned sales add to over-all profit. However, judgment and understanding are required in using marginal income figures for this purpose. It is necessary to consider the long range aspects of such business in order to avoid commitments which cannot be dropped when more profitable orders are available. Control over sales mix also needs to be exercised in order that sales of the less profitable items may be restricted to a volume sufficient to absorb overhead on capacity for which a more profitable use is lacking.

While the marginal approach is sometimes thought to be useful only as a tool for determining how far a company can go in meeting price cutting competition in a period of low sales volume, the field study showed that it is equally useful under conditions of capacity production. When available sales volume exceeds production capacity, it becomes necessary to decide which products are to be made and what markets to serve. The best profit attainable with the production capacity available can then be

[1] For a more detailed description of such applications of marginal income figures, see T. R. Elsman, "Profit Action Figures," *N.A.C.A. Bulletin*, April 15, 1946, and George L. Faulkner, "Profit Analysis for the Magnet Wire Industry," *N.A.C. Bulletin*, September 1952.

attained by choosing products or markets which carry the largest effective marginal income ratios.

While the discussion above has been presented largely in terms of products, the same approach is applicable to other volume segments such as territories and customers. For example, one company applies this analysis to determine which foreign branches are worth having. These branches do not always return the full amount of fixed cost allocated to them, but they may nevertheless increase over-all profits by contributing to the fixed overhead which would continue if a branch were abandoned.

2. How many units must be sold to realize the desired net profit (or return on investment) from a product, sales outlet, or other segment? Such calculations are quickly and directly made by dividing the marginal income ratio applying to the unit in question into the amount of fixed costs and profit applicable to the segment.

3. How much additional volume will be necessary to maintain present profits following an action which reduces sales realization or increases selling expenses? Several companies stated that sales management frequently proposes price reductions, discounts, and extra expenditures for sales promotion in order to increase sales volume. By first determining how much additional volume will be needed to avoid loss of profits, discussion can then be turned to the possibility of securing this volume. It was stated that this test had resulted in eliminating a number of proposals which would have required added volume which was obviously unattainable. On the other hand, products and markets carrying a high marginal income often indicated good opportunities for added sales promotion. Where management is guided by ratios of expense to sales in which expenses include both fixed and variable costs, it may hesitate to take actions which increase these ratios even though profits might be increased by spending more for selling and advertising. So long as there is some marginal income left on the added volume, over-all profit is increased despite the fact that the over-all ratio of sales expenses to sales income increases.

4. Will profits be improved by dropping an "unprofitable" product, territory, or customer? Any segment of the business which produces a margin over direct costs adds to the over-all net profit notwithstanding the fact that the individual segment may show a net loss after charging it with its share of the fixed costs. This question is therefore quickly answered when marginal income ratios by segments are known, but requires roundabout calculations by the absorption cost approach. To illustrate this application of direct costing methods, one of the companies interviewed had found an important product line to be consistently unprofitable. Management seriously considered abandoning this line, but decided to continue it for a time at least when it was shown that sales income was sufficient to cover direct costs and that there was no alternative use for

plant capacity which would become idle. Subsequently an item-by-item analysis of the line showed that some items carried adequate marginal income ratios while other items failed to return their direct costs. This indicated that by changing the sales mix and by increasing over-all sales volume, the line could be made profitable. Efforts to accomplish this proved successful. The company's accountants expressed the opinion that owing to the large number of items produced and sold under conditions where fixed costs were largely joint, information needed by management to solve this problem could have been obtained only by the direct costing approach.

DIRECT COSTING AS A GUIDE TO PRICING

In pricing, management must consider the volume of merchandise that can be sold together with the unit price received because both of these factors affect the amount of profit realized. It is evident that unless the combination of price and volume obtainable returns all costs in the long run, there will be no profits. For this reason, all costs are alike in their significance for determining costs as guides to long range pricing policy. That this reasoning is applied in practice can be seen in the fact that all of the companies interviewed have methods for assigning all costs to product classifications to develop product costs for use in pricing decisions even though inventories are, in some cases, costed at direct cost.

At the same time, pricing is not simply a matter of finding full cost of each product and adding a desired profit. In pricing, costs are often recovered by selling numerous items, some of which contribute more than others, to the portion of the over-all cost which is fixed and joint as to the items within a line. Moreover, the proportions in which individual products contribute to total cost may vary in different markets and at different times.

Unit variable cost has a constant relationship to unit selling price regardless of volume within the limits of available capacity.[2] On the other hand, unit fixed costs do not have a constant relationship to unit selling prices. The best selling price for an individual item is the one which, multiplied by the quantity which can be sold, yields the largest dollar contribution to fixed costs and profits. In practice, this aim can only be approximated because estimates of quantities which can be sold at different prices are largely guesses. Moreover, competition sets definite limits to the possible range of selling prices. Under such circumstances, the principal advantage of direct costing is that it enables management to give separate consideration to variable and fixed portions of a product's cost.

[2] While generally true, exceptions to the above statement may occur. For example, increased volume may enable companies in some industries to obtain better yields from material.

DOES DIRECT COSTING PROPERLY REFLECT PERIODIC INCOME?

While accountants are generally agreed that profits are not realized until goods are sold, the amount of profit reported for a given period is influenced by the methods used to calculate the cost of the goods sold in that period. Practice in this area of accounting shows a considerable range of variation and it cannot be said that there exists any one generally accepted theory or practice with respect to determining cost of the goods sold.[3]

Variable manufacturing costs are product costs under both direct and absorption costing methods. The two methods differ only in that direct costing treats fixed manufacturing costs as period costs while absorption costing treats the same costs as product costs. Advocates of direct costing argue that only the direct costs are specifically identifiable with goods manufactured in a given period and that fixed costs are, by nature, period costs. Those who prefer absorption costing contend that product cost (and by inference inventory cost) should include a prorata share of the costs of all manufacturing facilities used to produce the goods.

Therefore, the question at issue is whether, for the purpose of measuring periodic income, fixed manufacturing costs should be charged against income:

1. In the period when goods which received benefits from the manufacturing facilities are sold (i.e., absorption costing).
2. In the period in which the costs occurred regardless of the utilization of related facilities to produce goods (i.e., direct costing).

In the long run, all fixed costs must be recovered out of sales income before a profit is made. Moreover, it is generally agreed that interim profit figures should add up to the total for a series of interim periods. The interim period must therefore bear its proportionate share of the fixed costs in order that interim cost figures may also add up to the total costs for a series of interim periods. Long run total profit will not be affected by changing the distribution of a fixed sum of costs among the interim periods, but the profit for an individual interim period will be changed. Hence, the question which remains is how the fixed costs should be distributed among the interim periods.

The first procedure listed above, i.e., absorption costing, allocates fixed costs first to periods and then to products made during each period. When the full fixed cost of the period is assigned to units produced during the period, unit costs tend to lose usefulness when production volume fluctuates within a wide range. The practice of charging production with fixed cost at a rate based on normal or standard volume and charging any

[3] Some of these differences in practice were described in "Costs Included in Inventories," N.A.C.A. Research Series No. 10.

unabsorbed fixed cost against income was devised to avoid the objectionable features of unit costs which rose when volume declined. In justification, it was reasoned that the underabsorbed fixed cost balance represented a cost of idle capacity rather than a cost of production. In a sense, this was a step toward direct costing because it recognized the fixed cost of unutilized factory capacity as a period cost.

Direct costing follows the second point of view under which fixed costs are treated in their entirety as period cost. The reasoning which underlies this practice is that fixed costs are costs of having capacity to produce and that they expire with the passage of time regardless of the extent to which the facilities are actually utilized. For this reason, fixed costs have a determinable relationship to time which makes it possible to measure the amount of cost applicable to each period. On the other hand, the same costs have no determinable relationship to product units and can be assigned to the latter only by making an assumption as to the volume base. If this base is determined by actual volume experience in a given period, it is unrelated to the amount of cost being allocated because it may vary greatly from the volume for which facilities have been provided. The resulting unit costs fluctuate inversely with volume. If a normal or standard volume base is chosen, the fixed costs are likely to be over or under absorbed and the stability of unit costs is more apparent than real.

If the fixed costs do, in fact, expire with the passage of time they should be charged against income of the period in which expiration takes place. Absorption costing fails to meet this objective because it charges fixed costs to an asset account, i.e., to inventory. To the extent that the goods produced during the period remain in the inventory at the end of the period, these fixed costs are carried forward to the next period as assets. Periodic profit figures are therefore affected by inventory changes as well as by sales volume. The sale of a specific quantity of goods is made the basis for matching fixed manufacturing costs with income rather than the time the costs expire. As a result profit is shifted from one period to another by accumulating or reducing inventory. Proponents of direct costing object to this on grounds that profits are realized by sales and not by manufacturing goods for inventory. For this reason, they feel that profits should vary directly with sales volume so long as other factors such as selling prices, sales mix, and unit cost remain constant.

Section E:

ADMINISTRATIVE CONTROL AND THE FUTURE

The articles in this section are included in this book of readings as a separate group because of their titles—all of which have to do with either forecasts of future practices or projections of management factors into the future. It should be possible for the reader to make similar forecasts on a "do-it-yourself" basis based largely on an appraisal of the refinements or expansion of various materials included in the articles up to this point. Many of the authors have indicated some path of future development, based on present trends or opportunities, or on personal opinion.

The articles by Wroe Alderson and James A. McFadden, Jr., are probably more in the nature of practical extensions, refinements, or additions to present practices or methods in the selected areas of marketing and research and development.

The articles by Peter F. Drucker and Harold J. Leavitt approach the matter of prediction by boldly evaluating and projecting various innovations, trends, and emerging social and business attitudes. The changing characteristic of the workforce, management, and the population, appears to be one of the most important factors influencing the future course of events. Important changes in technology are also

anticipated, not the least important one being the radically improved speed and accuracy of the widely expanded information which management will have at its disposal and which it must learn to use effectively in a potentially more competitive environment.

XVIII

ADMINISTRATIVE CONTROL AND THE EXECUTIVE

70. NEW CONCEPTS OF INFORMATION FOR MANAGEMENT DECISIONS–IN MARKETING

Wroe Alderson*

The author explores the role which expanded marketing information will play in the future. The use of new methods and concepts will become increasingly important in planning, as it applies to marketing.

The goals of scientific marketing are market expansion and marketing efficiency. All we want as marketeers is to expand our sales and to control or reduce our marketing costs to have something left for profits. But the breadth of perspective and the refinements of techniques with which we seek these ends have developed with breath-taking speed in the post-war period.

AN INPUT-OUTPUT SYSTEM

All of these improvements in techniques rest on a fundamental conceptual advance. We have come to see the business firm as an operating system, to analyze it in terms of its inputs and outputs, to understand its

* From *National Association of Accountants Bulletin,* XL, 12 (1959), 11-18. Reprinted by permission of the National Association of Accountants.

destiny as an organic and growing entity in its marketing environment. The application of systems analysis to business activities is the common element of contemporary developments in marketing counsel, operations research, and cost accounting. One aspect of an effective operating system is the flow of information and analysis to facilitate decisions. The market analyst, the operations researcher, and the cost accountant perform their services to management with greater insight in terms of this systems perspective. A system has some analogy to a machine or a living organism. It differs drastically in the way that it achieves coordination through the collection and transformation of information. The analyst, meditating on his role within the system, might think of information either in terms of where he gets it or how it is going to be used.

The first view leads to dividing the informational problem of a firm into internal and external studies. This division is related to the way that information is obtained rather than to the way it is used. Internal studies pertain to the resources and activities within the firm. This phase of the informational service to management would include the normal accounting records and analytical studies based on these accounts. External studies pertain to the relations of the firm to its environment and particularly to its markets. Typical would be the forecasts and studies of demand for the company's products ordinarily carried on by a marketing research department. Accounting came first for a number of reasons, including the fact that data on what was going on inside were more readily available. It was only some fifty years ago that management began to grasp the possibilities of gaining reliable information about the external relationships of the firm through such methods as consumer surveys.

Internal and external studies are not alternatives for each other or merely useful complements. Rather, both are essential elements in the informational groundwork for decision-making. In fact, the art of management might be said to consist precisely of taking account simultaneously of the inner workings of the firm and its interaction with external forces.

We will be primarily concerned here with the classification of information along functional lines or, in other words, according to the types of decision-making in which it will be used. It will be helpful to go back to the analogy of a machine to point up the differences in a three-way functional classification of information used by management. First considered is the information used in current and short-run control of a machine, whether it be an automobile or a turning lathe, taking for example the drift of an automobile toward the shoulder in rounding a curve which leads to slight corrective pressures on the steering wheel. Next is the situation of uncertainty resulting in a slowdown or stoppage of the operation. The driver has now paused at a crossroad not knowing which fork to

take. He looks at his maps, asks questions of passersby and considers alternatives if the predetermined route turns out to be impassable. The driver may have also stopped at a repair station because he is doubtful about the performance of his car. The third situation is that in which the car or the lathe is being operated experimentally by an engineer or designer to determine its faults and limitations. His goal is to create a new design which will achieve improved performance. In terms of general systems analysis, the three types of decision-making might be called control, problem-solving, and development and planning.

CONTROL

Control works on the principle of feedback from current operations for minor adjustments designed to keep activities on target. Problem-solving combines internal and external data, often collected for the specific occasion, to resolve uncertainties as to the general direction which activities should be taking. Planning undertakes to design a new system which diverges in greater or lesser degree from the present system. In its more limited phases, planning would only attempt to modify the amounts of various inputs going into the system. In the more comprehensive and long-range versions of market planning, both the character and the amounts of both inputs and outputs are wide open for review and recommended changes.

The dual, inside-outside character of informational needs pervades all their aspects, although it may be least obvious in the case of control data. A full realization of this principle is something I would like to urge upon all cost accountants and, in fact, on other staff analysts, such as those engaged in marketing and operations research. Consider, for example, some of the most basic aspects of control information in business, such as quality control, inventory control, and budgetary control. The procedures of quality control are carried out in a laboratory, whereas the policies are imbued with marketing considerations. We have seen products priced out of the market due to quality control at a higher level of quality than consumers demanded. We have seen products misdirected due to quality control on qualities which were of relatively little moment to the consumer. I have seen operations researchers work out perfectly good formulas for inventory control, lacking only one small piece of information which they assumed could be supplied by someone else. This was an estimate of the cost to the company of losing sales which would enable the analyst to decide on the level of service to plan for. Obviously, the cost of lost sales requires marketing information and a high level of marketing judgment. Furthermore, it is an emotionally charged subject, thus making it difficult to get general acceptance of any proposed objective measure.

Budgetary control has an honorable tradition as an aid to management and has been carried out successfully while relying solely on data generated internally. This may still be feasible if budgets are regarded solely as a set of financial limitations imposed by management. A more advanced view of a sales or advertising budget is that it reflects a two-way commitment between top management and the department head. Management pledges resources, and the responsible executive pledges organized effort, both being related to agreed-upon objectives. More and more the sales or advertising executive is being required to submit a written plan in support of his budget request. Marketing plans which will stand up under critical review must make use of information derived from external studies of the company's markets. Once more, inside and outside sources appear to be inseparable in providing an adequate foundation for control decisions.

PROBLEM SOLVING

In the problem-solving area, marketing is generally reaching for some sense of direction either as to the markets to be cultivated or as to the marketing methods to be used. With companies not accustomed to the use of market surveys to estimate demand, the chief reliance is likely to be on trends in company sales and industry-wide forecasts prepared by outside organizations. Making the best use of either type of data is obviously a problem in market analysis. Studies of marketing costs can sometimes produce useful results, relying on existing internal records or data which can be generated without external research. I have previously referred to my own government experience in directing many studies of this type. These studies in the main dealt with the operations of retailers and wholesalers whose expenditures for influencing consumer demand are relatively modest. Now that we are undertaking similar studies of marketing costs for manufacturers, we frequently find that we cannot do an adequate job using internal data only. Suppose we are asked to state the optimum amount to be spent for advertising or some other form of marketing effort. To answer this we must estimate the consumer response function, and to draw the curve relating expenditures to results we must make use of marketing research and marketing experiments.

PLANNING AND DEVELOPMENT

It is the third area of decision-making—that concerned with planning and development—in which we have the greatest need for synthesis of data drawn from many sources. Further, if we are to develop the disciplines of marketing and business planning which management requires, we must utilize the techniques of all types of staff specialists, including cost

accountants and marketing researchers. The need for marketing to employ concepts and techniques originating in accounting is represented by the currency of certain phrases in marketing circles. I have referred to the years of my association with distribution, or marketing cost analysis. More recently, my firm and others have developed the concept of the marketing audit. We are now making various revisions of this notion, such as the pre-plan audit. By this we mean a careful assessment of where we are preliminary to the consideration of where we "go from here."

Even more significant is the growing use of pro forma operating statements as a major tool of planning. The goals of business planning may be stated as the effort to reach certain operating levels during some specified future time, which might, for example, be the calendar year 1965. Surely it is not enough to forecast company sales volume for that year. Management also needs a forecast of the price level relating dollar volume and physical volume of output. Profits for the firm in 1965 will consist of the margin of sales volume over the total of all the constituent elements of the cost or expenditure side of the operating statement. The pro forma statement, so conceived, is a summary presentation of a set of forecasts for dollar volume, prices and profits. These forecasts cannot be deduced without the various types of information derived from marketing research and planning.

A pro forma statement for 1965 must be supported by a similar statement for 1964 and so on backward to the present. To set up such a series of statements merely as a projection of last year's figures would be an almost trivial exercise. Costs are incurred in one year with the purpose of augmenting sales and profits in following years. A target as to dollar volume requires a level of marketing expenditures estimated to stimulate that level of demand. The costs of providing the product demanded must be covered by what is left before there is anything for profits. The forward look at what it is going to cost for materials, labor, and productive equipment will carry both the accountant and the marketing researcher into fields which have been explored by very few in either camp.

Market planning is not the whole of business planning, but it is safe to say that marketing considerations are fundamental to any decisions on business plans and policies. Investment and capital budgeting comes back to the kind of facilities which will be needed to supply the markets of the future. Personnel recruitment and training is preparation to perform the tasks which the consumer needs of tomorrow will impose. The budgets for technical research and development will increasingly be devoted to product ideas where there is some evidence of promising markets. Marketing forecasts and programs on the other hand will necessarily take on more of the quantitative and precise detail which is familiar in accounting. Loose concepts, such as market potential, must be translated

into market response functions showing sales expectations at various prices and various levels of marketing expenditure.

Accounting was undoubtedly the first staff function generating aids for management judgment. It anticipated by some years the doctrine now accepted by various types of analysts that the business firm should be viewed as an input-output system. As a matter of fact, a business is a dual system relating respectively to flows of money and goods. From the financial viewpoint there are inputs of investment and current expenditure and outputs of profits. From the operating point of view there are inputs of goods or materials purchased from suppliers and outputs of goods sold to customers. Accountants, by virtue of their traditional role, have tended to emphasize one aspect, and market researchers the other. Market planners need to be reminded that no plan is valid which does not point to a specific profit objective. Accountants may need to be reminded that the only ultimate source of profits is market demand for the company's products and services. Both need greater skill either in direct collaboration or in translating their results into a form that is useful to the other.

Let us return to the analogy previously suggested between business planning and the design of a new and improved version of a machine. I suggest that each of you consider the outlook for your own firm and try to picture what it will look like in 1965. If your present products are sold largely to some limited age group, such as the home-makers of from 20 to 40 years, then over a quarter of your customers for 1965 are not yet in the market today. If your firm is technologically progressive and determined to grow through new product introduction, more than half of your sales in 1965 may come from products which are not now in your line. If the turnover in your sales force is as great as many of the large companies experience, your sales in 1965 will largely be made by salesmen your firm has yet to employ. The importance of planning decisions for management is underscored by the fact that the success of your business in 1965 will rest in a very major way on the efforts of new salesmen (men you have not yet hired) selling new products (products you have not yet introduced or perhaps have not yet even designed) to serve the needs of new customers (customers who have not yet matured to the point of being prospective users of your products).

Planning can be described in many ways, but one part of its responsibility is to match resources against prospective opportunities as they will exist in the business environment of some future date. Attempting to balance effort and opportunity five years from now may seem like a hazardous extension of the known into the unknown. But planning is coming rapidly forward because the hazards of planning are not as great as the hazards encountered without planning. Progress in any area usually comes

through an act of the imagination. Perhaps the establishment of a central planning unit can be described as a systematic attempt to equip the firm with an active imagination of its own.

A MORE PREHENSILE MANAGEMENT MIND

In summary, it can be said that the newer concepts of information for decision-making start with an investigation of the business firm as an input-output system. Staff analysts can in turn understand their own function in terms of inputs and outputs of information. The outputs can be classified functionally as designed for control, problem solving, and planning. The new discipline of systematic business planning, in conjunction with the mechanical aids of electronic data processing, tend to endow a business with imagination, memory and reason. Or, stated more literally and accurately, they serve to expand tremendously the outreach of these functions of the human mind.

71. NEW CONCEPTS OF INFORMATION FOR MANAGEMENT DECISIONS—RESEARCH AND DEVELOPMENT

James A. McFadden, Jr.*

The author suggests an approach to gathering information about research and development which uses reports and information not based solely on the familiar budgetary control.

The primary difference between the management of a research and development program, as contrasted with a marketing effort or a production operation, is the matter of certainty of accomplishment. Yes, accomplishment in terms of achievement that may be measured economically. Frequently, any accomplishment that can be recognized either scientifically, economically or even academically is at the most uncertain and, unfortunately, no amount of management planning and control will guarantee any degree of certainty during any period or at any given point of time.

In the management of research and development there is *no* certainty of the results that will be accomplished. Expenditures for research and development are very much like expenditures for advertising. It is true that a payoff is expected and, in long-range programs, will eventually oc-

* From *National Association of Accountants Bulletin,* XL, 12 (1959), 19-26. Reprinted by permission of the National Association of Accountants.

cur. However, timing of results as related to fiscal periods is something which defies the most astute management planning and control efforts. Advertising expenditures as a rule will produce a high immediate return, with trailing benefits as time progresses. Research and development expenditures on the other hand usually produce an opposite effect. At the outset there is no return or, if any, the return is small. In long range research programs, however, the benefits increase with the passage of time for, as more and more knowledge is acquired, new products, processes, techniques and so forth are developed. There is, however, no certainty as to when such discoveries will occur, and this fact is what drives most accountants and financial managers stark, raving mad! Not to conduct large-scale, long-range research and development programs, however, would be tantamount to industrial or national suicide.

The problem facing corporate managements today is not whether to make research and development expenditures but in what scientific areas should such funds be spent. Also, standard accounting information, including cost comparisons by individual projects, contribute very little to helping management reach decisions in this respect. An entirely different concept of supplying research management with information to make decisions must be developed. Columnar presentations of dollar comparisons will develop nothing more than to indicate "how much" was spent for research and development in the aggregate, whereas management needs and must know whether such funds were spent: (1) on the proper projects, (2) in the best scientific areas so far as the company's commercial interests are concerned, (3) should more or less be spent on research and development in view of the company's present and future plans, (4) are the space, facilities and scientific talent of the research department directed in the channels that will produce the best long-range benefits. These and similar questions must be answered by the information that is supplied to research management if such data is to contribute at all to decision-making.

SOME PENETRATING RECORDS

At the risk of being accused of perpetrating a heresy, I am recommending that information similar to that shown on EXHIBITS 1 and 2 be prepared by the controller's department of large industrial organizations for the use of research and development managers. These exhibits indicate to the research director the amounts of space, equipment and service expenses expended by each member of the scientific and technical staffs in each area of scientific exploration, in addition to the cost relationship of each scientific endeavor to the total project cost.

To the research director, the application of staff and facilities to each facet of research processes is all important. Burden costs such as fringe benefits, telephone, depreciation of equipment and apparatus, et cetera,

constitute in his mind either a cost of having the scientist on the premises or supplying a space for him to work. Accordingly, all overhead costs, including salaries of service personnel, are grouped for the factor used to price out the annual or other period cost of the scientist. Similarly, all those fixed or variable costs applicable to buildings, facilities or scientific apparatus are included in the amount used to value the floor space occupied by the scientific or technical staffs. It can reasonably be argued that there are wide variances in the amounts of space, apparatus and equipment needed and utilized by different segments of the research team. As a practical matter, this is true but only so in a physical arrangement sense. The purely theoretical physicist or chemist may only occupy desk space and his equipment needs may not individually exceed slide-rule and desk-calculator proportions. The experimentalists, on the other hand, may require large floor space areas containing a diversified array of very expensive test equipment. However, the complexities of modern day science are such that explorations and discoveries are only possible by the combination of many intellectual skills and talents. In the research laboratory, every attempt is made to create an atmosphere that will cultivate an association and cross-pollination of ideas. It is not specious reasoning, therefore, to assume that every member of the scientific staff potentially has use of, or causes to be used, the laboratory space and facilities in identically the same measure.

It is well to state at this point that information of the type illustrated on the two exhibits cannot be extracted from the books of account *per se*. Average costs per member of the scientific and technical staff can be developed periodically, which are applied to the number of staff members working on each task or project monthly. A nose count of people is readily attainable from the project time reports. A facility cost average is also developed and steps are taken to have periodic space utilization reports submitted to the cost accounting function. In practice, this presents no real problem, as the scope of the research program does not change rapidly enough nor without requiring other financial considerations, to create any significant degree of inaccuracy. Strangely enough, if the entire research staff and all facilities are priced out in this fashion, variances are remarkably narrow, due to the uniform pattern of actual cost incurrence that is normally experienced. Any variances are not indicated in the data supplied to the director of research unless they are sizable and then are shown only by footnote reference. At the close of the annual period, variances are adjusted by necessary year-to-date adjustments to the average costing media.

By the same token, the usual presentations made in account fashion for capital appropriations and commitments should be geared in a research operation to the amount of capital expenditure for a given period per

EXHIBIT I

OHM R&D DEPARTMENT

APPLICATION OF STAFF AND FACILITIES

PROJECTS	THEORY			SYNTHESIS			EXPERIMENTATION			MATERIALS AND DEVICES			TOTALS		
	BAYS	MRS	TECH	BAYS	MRS	TECH	BAYS	MRS	TECH	BAYS	MRS	TECH	BAYS	MRS	TECH
Thermoelectrics	$ 7	$ 7	$ 10	$ 7	$ 7	$ 10	$ 2	$ 2	$ 2	$ 2	$ 2	$ 4	$ 18	$ 18	$ 26
Optics	3	4	4	3	4	4	1	2	1	1	1	2	8	11	11
Luminescent Materials	5	4	6	5	4	6	3	5	1	—	—	—	13	13	13
Electronics	2	2	4	1	2	1	22	30	35	5	5	7	30	39	47
Acoustics	2	1	3	—	—	—	10	15	10	5	5	4	17	21	17
Microwave	2	2	2	—	—	—	10	12	10	1	2	2	13	16	14
Nucleonics	4	5	3	3	2	4	1	1	2	—	—	—	8	8	9
TOTALS	25	25	32	19	19	25	49	67	61	14	15	19	107	126	137

Proposed By:
Accounts and Finance Department
July 6, 1959

LEGEND: BAYS — FLOOR SPACE AND EQUIPMENT
MRS — MEMBERS RESEARCH STAFF
TECH — TECHNICIANS

EXHIBIT 2

OHM R&D DEPARTMENT

SUMMARY OF PROJECT COSTS — JANUARY 1 TO JUNE 30, 1959

(IN THOUSANDS OF DOLLARS)

PROJECTS	THEORY			SYNTHESIS			EXPERIMENTATION			MATERIALS AND DEVICES			TOTALS		
	SPACE	STAFF	BUDGET	SPACE	STAFF	BUDGET	SPACE	STAFF	BUDGET	SPACE	STAFF	BUDGET	SPACE	STAFF	BUDGET
Thermoelectrics	$ 35	$ 70	$ 100	$ 35	$ 70	$ 100	$ 10	$ 20	$ 50	$ 10	$ 20	$ 50	$ 90	$ 180	$ 300
Optics	20	40	60	10	40	60	10	20	40	10	15	30	50	115	190
Luminescent Materials	20	40	50	20	40	50	25	50	80	—	—	—	65	130	180
Electronics	10	20	30	5	20	30	150	300	450	25	50	100	190	390	610
Acoustics	5	10	15	—	—	—	75	150	225	25	50	75	105	210	315
Microwave	10	20	30	—	—	—	60	120	200	10	20	30	80	160	260
Nucleonics	25	50	50	20	60	30	6	12	15	—	—	—	51	122	95
TOTALS	125	250	335	90	230	270	336	672	1060	80	155	285	631	1307	1950
												VARIANCES	3	11	-0-
												ACTUAL	634	1,318	1,950

Proposed By:
Accounts and Finance Department
July 6, 1959

member of the technical or scientific staff. In practice, capital appropriations and expenditures are usually expressed in four general categories: (1) scientific equipment, (2) buildings, (3) technical service equipment, (4) administrative or office type equipment and fixtures. Time does not permit a more comprehensive consideration of the data required for management decisions with respect to capital transactions. However, the type of data necessary for such decisions differs appreciably from that commonly used in other types of operations.

It is not to be inferred that these data should be supplied only on an actual and after-the-fact basis. Annual budgets should be prepared in this format at the outset of the calendar or fiscal period. Of necessity, these budgets will be variable, depending upon the shifts in emphasis that occur in the research program. However, comparative statements will immediately indicate to the research director why and what has caused the changes in the applications of efforts and funds. Merely knowing that more or less money is spent on a project does not indicate anything of significance so far as scientific progress is concerned. The knowledge of how much talent, space and instrumentation is applied to each phase of a research project permits decisions to assure control that is otherwise extremely difficult to attain.

PRACTICAL NEEDS FOR INFORMATION

In the management of research and development, "shot gun" techniques are sometimes used in the application of the various scientific talents. Data with respect to the usage and cost of each pellet within a particular technological discipline can be utilized by research management to determine if sufficient emphasis is being maintained in the areas important to improving or supplementing the company's existing and contemplated product lines. Unless such control is exercised, pure scientific curiosity upon the part of the research staff may result in the condition that much of the total research budget is expended upon projects the fruits of which may offer little or no utility value to the particular organization. As an example, the technology of space travel and satellites generates much scientific enthusiasm among researchers. In addition there are considerable sums of money available from the Federal Government to do research and development in this area.

Regardless of the possible future applications of the discoveries that may come from such research, it is possible that, with the limited present availability of good research talent, a company could well find all of its "eggs in one basket" from a research viewpoint to the detriment and neglect of many projects important to its other product lines. Accordingly, it is important to understand that the availability of money and the

reporting by project of money spent does not assure a research program that is valuable or important to a corporation's economic existence.

Further, it must be remembered that no company can do more than approximately 2 per cent of the total research that is conducted in this country in the fields covered by its business. It follows, therefore, that the other 98 per cent represents in effect intellectual and materialistic competition. Universities, Research Foundations and other Industrial Research Laboratories are pursuing research programs which are providing additional knowledge in a given field. These programs cannot be in any way controlled by an individual company or industry and it is only a matter of "where" and "when" the answers are first developed.

It appears imperative, therefore, that the management of research and development employ and deploy the scientific staffs available to them in a manner that will concentrate the effort and talent on tasks which are conducive to producing decisions susceptible to commercial exploitation within the company's sphere of product activity. Also this must be done without curbing to any great degree the intellectual freedom and curiosity which is vitally necessary in any good researcher. To accomplish this type of direction, information geared to the utilization of talents, facilities and instrumentation, rather than the expenditure of dollars as such, is required for the management decisions that will implement the shifts in emphasis that are constantly required in any dynamic research and development program.

72. THE NEXT DECADE IN MANAGEMENT

Peter F. Drucker*

A leading author in management forecasts important changes for business in the 1960's to occur in the areas of the workforce, innovations, markets, finance, and international and national policies toward business.

For any one company at any given time in the next decade, there may well be a single, central problem of management. But every experienced manager knows that running a business is always a multi-dimensional job,

* From *Dun's Review and Modern Industry*, LXXIV, 6 (1959), 52-53, 57-59. Copyright, 1959, by Dun & Bradstreet Publications Corporation. Reprinted by permission of the publisher.

that indeed the essence of management is the balancing of challenges and demands from many quarters.

In summing up the management outlook for the 1960's, I shall therefore touch on many problems, rather than attempt to discuss a central problem thoroughly. Actually, there are four main areas in which managers today might profitably prepare themselves for new challenges and new opportunities.

1. *The greatest changes may well come in the structure of the American workforce and in the management and organization of people at work.*

Managerial, professional, and technical people are by now the largest single group in the American labor force, far outnumbering the hourly-paid machine operators. They are also the fastest-growing group and may well double in number within the next decade. By the end of the 1960's, they will account for the bulk of American business' wage and salary bill. And by 1970, every other young man (and every third young woman) entering the labor force for the first time will have been to college and will therefore expect to move into technical, professional, or managerial work.

One effect will be an increasing rigidity of the cost structure of business. People who do "knowledge work" enjoy, by and large, high stability of employment. Their numbers do not fluctuate with production volume, except over fairly long time periods. Whereas "labor" is still considered by accountants and economists as a variable cost, it will become increasingly a fixed cost for the businessman. Indeed, this is how personnel costs actually behaved during the 1957-58 recession.

Managers will therefore have to learn new ways of cost accounting—cost accounting, for instance, in which time periods, rate of utilization of capacity, and product mix, rather than "unit costs," are the basis of costing and pricing. We will also need much better controls over the size of technical, professional, and managerial staffs and of their composition. Otherwise, we shall run the risk of inflating during good times, only to find that we are stuck with unsupportable overhead when business turns down.

But the real problem will be the management of the knowledge worker. So far, we know what he costs, but we cannot measure what he contributes or what he should contribute. We have no gage of productivity for the research chemist, the wage and salary administrator, the quality-control man, the plant engineer, or division manager. Yet, clearly, the productivity and results of every business and of the entire economy increasingly depend upon the contributions of these people.

The manager faces equally difficult and even more subtle problems in respect to treatment, pay, and promotional opportunities for the knowl-

edge worker. Most of them are specialists concerned with a single field of knowledge. Yet, they must direct their work toward the common end of business performance and business results. They have to work as individuals; yet they must work together as a team. To be effective, they need a manager, just as the manager needs their knowledge and dedication to be effective in his work.

Effective personnel management of the knowledge worker may require as much study as has been devoted in the past 25 years to the personnel management of the manual and clerical worker.

The demand for people trained in manual skills is growing steadily. Popular myth to the contrary, mass production has not eliminated skill—it steadily calls for more skilled men. Automation, too, greatly increases the demand for skilled men. But the supply is shrinking.

Every conceivable approach to the solution of this problem involves abolition—or at least sharp modification—of time-hallowed craft jurisdictions, craft skills, craft pride. Any attempt to overcome the shortage of skilled workers will, therefore, create serious conflicts with the most powerful, most deeply entrenched, and most respected unions in the labor movement—electricians, typographers, machinists, and so on.

2. *An entirely different but no less serious challenge for the American manager lies in the increasing tempo of innovation.*

Industrial research expenditures in this country now run around $5 billion a year—exclusive of defense-focused research. Thirty years ago, at the crest of the boom of the 1920's, the total industrial research budget of the country was well under $100 million. The real increase has occurred in the past five years—which means that the full impact of all this research is still ahead of us.

Even more important is the structural change in research efforts. Thirty years ago, industrial research was essentially confined to a few large companies in a handful of highly technical industries: the electrical industry, communications, the chemical industry, the pharmaceutical industry. Today, no industry is without major research efforts (and many small companies spend proportionately more on industrial research than do the giants). One of the outstanding research efforts of the past ten years was done not by a "growth" industry but by our oldest and most "mature" industry, cotton growers and spinners.

Again, the main impact of this change is still ahead of us—but not very far. Industry and marketing structures which most managers take for granted are likely to be severely shaken. Indeed, they are likely to be in a state of continuous flux.

Above all, managers will have to learn how to manage innovation. Where should innovation efforts be directed? How extensive and intensive should they be? What risks of innovation can a business afford to

take? What are the risks it cannot afford to take, and which are the risks it must take, even though the odds against success may be astronomical?

And then there is the big job of making the results of innovation truly profitable.

3. *This takes us into another problem area: marketing, especially the marketing of a new or improved product.*

As everybody knows, infant mortality among new products is exceedingly high—seven out of ten fail to make the grade and either die outright or barely manage to cling to a disappointing and unprofitable life. At the same time, the cost of introducing new products is climbing steadily.

This is only one of our marketing problems, of course. But it highlights three characteristics that are common to most of the marketing tasks we face: lack of knowledge, inadequate control, and mounting costs.

More people are today employed in the distributive process than in manufacturing and agricultural production combined. This is one of the major structural shifts of the American economy during the past 30 years. Since the people in distribution get the same income as the people in production, the distributive sector of the economy disposes of a bigger share of the national income than does the productive sector. But what about the productivity, the efficiency, and the effectiveness of our distribution system? Has it risen as fast as productivity in production? That is, are the factors that justify the higher income of the people engaged in production paralleled in distribution? Nobody can answer this question today. That advertising, for instance, is more "magic" than science, every business man has found out. Yet advertising is essential to mass marketing. And we know almost as little about pricing.

Unless the efficiency and productivity of distribution rise as fast as the productivity and efficiency of production, higher wages inevitably create inflationary pressure. If we in America suffer from a "wage-push" inflation, it is largely because wages in distribution are outracing productivity.

Even more important, perhaps, managers in general—and especially top management people—must learn to apply a marketing focus and a marketing orientation to their own work. Most managements today are still product or process-focused. They see the job of marketing as "selling what the plant produces." Comparatively few fully appreciate as yet that it is equally the job of the plant to produce what the market, and especially tomorrow's market, wants to buy.

Even fewer understand that what the consumer buys is not a product but the use he gets out of a product. *What the consumer buys and what*

the business produces are therefore different. To the consumer, for instance, the manufacturer's costs are quite irrelevant: the consumer's concept of price is based on what he expects to get out of the product rather than what the manufacturer puts in.

The American market of the 1960's is indeed a most promising market. But it will also be a tricky, if not a treacherous one. High income for large numbers means both greater capacity to buy and greater capacity to switch preferences, to change habits, to postpone purchases.

4. *The final area likely to produce new challenges within the manager's daily compass is financial policy.*

During the next decade, we are almost certain to face capital shortages. This will result partly from the sharp growth in the number of families in the country and the resulting demand for all kinds of community services, from housing to hospitals and roads. It will result in part from the tremendous accumulated replacement needs of American industry, which is becoming an old-equipment industry. It will also result from the capital demand arising out of innovation. Only disarmament on a global scale could change this.

At the same time, capital accumulation is increasingly concentrated in the hands of professional trustees: pension funds, mutual or personal investment managers, insurance companies, and so on. It is largely through these that the individual business increasingly will have to find access to the capital market, and not only for equity capital.

This will put an increasing premium on financial planning to ensure that the financial structure of a business is suited to its needs and economic characteristics. It will put increasing pressure on financial management to see that all capital funds are fully utilized, whether they are obtained from the outside or from retained earnings.

And it will increasingly require that companies develop a distinct and marketable financial "product" of their own, which will enable them to offer the financial satisfactions that fit the needs, wants, and expectations of the increasingly sophisticated, increasingly professional customers in the capital market—the professional trustees for other people's money.

Bigness in business is likely to be increasingly a problem of public policy in this country.

By and large, big business has been accepted as necessary, though not perhaps by everybody as desirable. But now we are asking new questions: What is the specific excellence and contribution of bigness? What is bigness really suited for? What are its limitations, what are its strengths and weaknesses? How big can a business grow and still be manageable? How diversified can it get and still be an organic whole? What should its

relations be with the small business it must live with as competitor or partner? In sharp contrast to earlier times, these questions are today increasingly asked within big business itself and by managers.

There is growing concern about the limits of bigness within management. Many companies feel that over the past ten years they have over-diversified to the point where they may be in danger of losing their unity. Some thoughtful managers also feel that our biggest companies are in danger of getting too big to be effectively managed under existing concepts of organization and with our existing tools of communications and control.

Bigness today is not peculiarly a problem of business. On the contrary, big organizations pervade our entire society: big business, big labor, the big—and almost unmanageable—armed forces, the sprawling metropolitan areas in which more and more of our population lives, the growing civil service—even universities are getting much too big to be manageable, let alone be "communities of scholars." The business world is distinguished primarily by the existence of so many thriving and growing small units —which in many cases, as we are beginning to realize, exist *because* of big business which enables them to gain access to the national market or to exercise their own specialized production skills.

During the next decade, the international economy is likely to loom larger in the work and the thoughts of American managers.

Many companies will be actively connected with it—as exporters or importers, through subsidiaries or license agreements. Even more will become aware of competition from abroad, both in foreign and the domestic markets—competition in quality and technological leadership, based upon high engineering and managerial skills and produced by the most modern equipment, if not with a higher degree of mechanization and automation than our own.

But perhaps the greatest challenge in the international economy will be a challenge to the basic attitudes of the American business man. He will have to learn increasingly—as his counterpart in Western Europe learned long ago—that the crucial test for our domestic industry is its ability to compete internationally. Ability to pay for imports, especially growing imports of industrial raw materials, will increasingly become an absolute requirement for our own country's economic growth.

Most American business men still believe, if perhaps only subconsciously, the slogans of the 1940's: American productivity and know-how lead the world; other countries need American goods more than we need theirs; the "dollar gap" is a law of nature. But the realities of the 1960's are entirely different realities.

TOOLS OF TOMORROW

In dealing with their new tasks, the managers of the 1960's will to a large extent have to employ the same tools they are using today. But managers will also find, increasingly, that they are expected to know, understand, and handle new concepts and tools of management. Increasingly, they will find that they are expected to use systematic methods of analysis and decision making, supplemented by new tools of communication, computation, and presentation.

Executives can safely disregard all the fanciful talk about the computer "replacing managers" and "making decisions." Managers' work, it can be said with confidence, is going to become more important and their numbers larger. But the "management sciences"—such as operations research or decision-making logic—and the new electronic tools and systems are going to make a difference, even to the manager in the small business.

And the manager of 1970 will need all the help he can get from such new concepts and tools. For his job is going to be so complex, so big, so demanding as to require all the tools of simplification and systematization that can possibly be obtained.

What all this adds up to is a special challenge to top management.

The challenges and opportunities I have outlined are above all challenges and opportunities for top management. They are primarily "policy" problems rather than technical matters. All require leadership and hard work on the part of top management people.

But the next decade will also see the greatest turnover in top management personnel we have seen in a long time. Our top managements today are, on the whole, older than they have ever been before in American business history—with almost two-thirds of top management people over 55 and therefore likely to retire between now and 1970.

A NEW GENERATION

The men who will retire, by and large, began their business career in the boom years of the 1920's and moved into management during the depression years. But their successors will be largely men who did not even start in business until after World War II, men to whom even the depression is only a dim childhood memory. It is this generation, as yet untried, that will face the new challenge and will have to prove itself worthy of the new opportunities.

Perhaps, after all, the next decade does confront American business with one central management problem. This problem is top management itself: its seriousness, vision, competence, knowledge, values, and leadership.

73. MANAGEMENT IN THE 1980'S

Harold J. Leavitt and Thomas L. Whisler*

The authors coin the phrase "information technology" which includes techniques for rapidly processing large amounts of information, mathematical programing, and for simulation of high-order thinking. The probable impact of this technology on management in the future is discussed, particularly the drastic effect on middle and top management.

Over the last decade a new technology has begun to take hold in American business, one so new that its significance is still difficult to evaluate. While many aspects of this technology are uncertain, it seems clear that it will move into the managerial scene rapidly, with definite and far-reaching impact on managerial organization. In this article we would like to speculate about these effects, especially as they apply to medium-size and large business firms of the future.

The new technology does not yet have a single established name. We shall call it *information technology*. It is composed of several related parts. One includes techniques for processing large amounts of information rapidly, and it is epitomized by the high-speed computer. A second part centers around the application of statistical and mathematical methods to decision-making problems; it is represented by techniques like mathematical programing, and by methodologies like operations research. A third part is in the offing, though its applications have not yet emerged very clearly; it consists of the simulation of higher-order thinking through computer programs.

Information technology is likely to have its greatest impact on middle and top management. In many instances it will lead to opposite conclusions from those dictated by the currently popular philosophy of "participative" management. Broadly, our prognostications are along the following lines:

1. Information technology should move the boundary between planning and performance upward. Just as planning was taken from the hourly worker and given to the industrial engineer, we now expect it to be taken from a number of middle managers and given to as yet largely nonexistent specialists: "operations researchers," perhaps, or "organizational analysts." Jobs at today's middle-management level will become highly structured. Much more of the work will be programed, i.e., covered by sets of operating rules governing the day-to-day decisions that are made.

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* From *Harvard Business Review*, XXXVI, 6 (1958), 41-48. Reprinted by permission of the *Harvard Business Review*.

2. Correlatively, we predict that large industrial organizations will recentralize, that top managers will take on an even larger proportion of the innovating, planning, and other "creative" functions than they have now.

3. A radical reorganization of middle-management levels should occur, with *certain classes* of middle-management jobs moving downward in status and compensation (because they will require less autonomy and skill), while other classes move upward into the top-management group.

4. We suggest, too, that the line separating the top from the middle of the organization will be drawn more clearly and impenetrably than ever, much like the line drawn in the last few decades between hourly workers and first-line supervisors.

THE NEW TECHNOLOGY

Information technology has diverse roots—with contributions from such disparate groups as sociologists and electrical engineers. Working independently, people from many disciplines have been worrying about problems that have turned out to be closely related and cross-fertilizing. Cases in point are the engineers' development of servomechanisms and the related developments of general cybernetics and information theory. These ideas from the "hard" sciences all had a direct bearing on problems of processing information—in particular, the development of techniques for conceptualizing and measuring information.

Related ideas have also emerged from other disciplines. The mathematical economist came along with game theory, a means of ordering and permitting analysis of strategies and tactics in purely competitive "think-" type games. Operations research fits in here, too; OR people made use of evolving mathematical concepts, or devised their own, for solving multivariate problems without necessarily worrying about the particular context of the variables. And from social psychology ideas about communication structures in groups began to emerge, followed by ideas about thinking and general problem-solving processes.

All of these developments, and many others from even more diverse sources, have in common a concern about the systematic manipulation of information in individuals, groups, or machines. The relationships among the ideas are not yet clear, nor has the wheat been adequately separated from the chaff. It is hard to tell who started what, what preceded what, and which is method and which theory. But, characteristically, application has not, and probably will not in the future, wait on completion of basic research.

DISTINCTIVE FEATURES

We call information technology "new" because one did not see much use of it until World War II, and it did not become clearly visible in

industry until a decade later. It is new, also in that it can be differentiated from at least two earlier industrial technologies:

1. In the first two decades of this century Frederick W. Taylor's *scientific management* constituted a new and influential technology—one that took a large part in shaping the design of industrial organizations.
2. Largely after World War II a second distinct technology, *participative management*, seriously overtook—and even partially displaced—scientific management. Notions about decentralization, morale, and human relations modified and sometimes reversed earlier applications of scientific management. Individual incentives, for example, were treated first as simple applications of Taylorism, but they have more recently been revised in the light of "participative" ideas.

The scientific and participative varieties both survived. One reason is that scientific management concentrated on the hourly worker, while participative management has generally aimed one level higher, at middle managers, so they have not conflicted. But what will happen now? The new information technology has direct implications for middle management as well as top management.

CURRENT PICTURE

The inroads made by this technology are already apparent, so that our predictions are more extrapolations than derivations.[1] But the significance of the new trends has been obscured by the wave of interest in participative management and decentralization. Information technology seems now to show itself mostly in the periphery of management. Its applications appear to be independent of central organizational issues like communication and creativity. We have tended until now to use little pieces of the new technology to generate information, or to lay down limits for subtasks that can then be used within the old structural framework.

Some of this sparing use of information technology may be due to the fact that those of us with a large commitment to participative management have cause to resist the central implications of the new techniques. But the implications are becoming harder to deny. Many business decisions once made judgmentally now can be made better by following some simple routines devised by a staff man whose company experience is slight, whose position on the organization chart is still unclear, and whose skill (if any) in human relations was picked up on the playground. For example:

[1] Two examples of current developments are discussed in "Putting Arma Back on Its Feet," *Business Week*, February 1, 1958, p. 84; and "Two-Way Overhaul Rebuild Raytheon," *Business Week*, February 22, 1958, p. 91.

We have heard recently of an electric utility which is considering a move to take away from generating-station managers virtually all responsibility for deciding when to use stand-by generating capacity. A typical decision facing such managers develops on hot summer afternoons. In anticipation of heavy home air-conditioning demand at the close of working hours, the manager may put on extra capacity in late afternoon. This results in additional costs, such as overtime premiums. In this particular geographical area, rapidly moving cold fronts are frequent. Should such a front arrive after the commitment to added capacity is made, losses are substantial. If the front fails to arrive and capacity has not been added, power must be purchased from an adjacent system at penalty rates—again resulting in losses.

Such decisions may soon be made centrally by individuals whose technical skills are in mathematics and computer programing, with absolutely no experience in generating stations.

RAPID SPREAD

We believe that information technology will spread rapidly. One important reason for expecting fast changes in current practices is that information technology will make centralization much easier. By permitting more information to be organized more simply and processed more rapidly it will, in effect, extend the thinking range of individuals. It will allow the top level of management intelligently to categorize, digest, and act on a wider range of problems. Moreover, by quantifying more information it will extend top management's control over the decision processes of subordinates.

If centralization becomes easier to implement, managers will probably revert to it. Decentralization has, after all, been largely negatively motivated. Top managers have backed into it because they have been unable to keep up with size and technology. They could not design and maintain the huge and complex communication systems that their large, centralized organizations needed. Information technology should make recentralization possible. It may also obviate other major reasons for decentralization. For example, speed and flexibility will be possible despite large size, and top executives will be less dependent on subordinates because there will be fewer "experience" and "judgment" areas in which the junior men have more working knowledge. In addition, more efficient information-processing techniques can be expected to shorten radically the feedback loop that tests the accuracy of original observations and decisions.

Some of the psychological reasons for decentralization may remain as compelling as ever. For instance, decentralized organizations probably provide a good training ground for the top manager. They make better use of the whole man; they encourage more active cooperation. But though interest in these advantages should be very great indeed, it will

be counterbalanced by interest in the possibilities of effective top-management control over the work done by the middle echelons. Here an analogy to Taylorism seems appropriate:

> In perspective, and discounting the counter-trends instigated by participative management, the upshot of Taylorism seems to have been the separating of the hourly worker from the rest of the organization, and the acceptance by both management and the worker of the idea that the worker need not plan and create. Whether it is psychologically or socially justifiable or not, his creativity and ingenuity are left largely to be acted out off the job in his home or his community. One reason, then, that we expect top acceptance of information technology is its implicit promise to allow the top to control the middle just as Taylorism allowed the middle to control the bottom.

There are other reasons for expecting fast changes. Information technology promises to allow fewer people to do more work. The more it can reduce the number of middle managers, the more top managers will be willing to try it.

We have not yet mentioned what may well be the most compelling reason of all: the pressure on management to cope with increasingly complicated engineering, logistics, and marketing problems. The temporal distance between the discovery of new knowledge and its practical application has been shrinking rapidly, perhaps at a geometric rate. The pressure to reorganize in order to deal with the complicating, speeding world should become very great in the next decade. Improvisations and "adjustments" within present organizational frameworks are likely to prove quite inadequate; radical rethinking of organizational ideas is to be expected.

REVOLUTIONARY EFFECTS

Speculating a little more, one can imagine some radical effects of an accelerating development of information technology—effects warranting the adjective "revolutionary."

Within the organization, for example, many middle-management jobs may change in a manner reminiscent of (but faster than) the transition from shoemaker to stitcher, from old-time craftsman to today's hourly worker. As we have drawn an organizational class line between the hourly worker and the foreman, we may expect a new line to be drawn heavily, though jaggedly, between "top management" and "middle management," with some vice presidents and many ambitious suburban junior executives falling on the lower side.

In one respect, the picture we might paint for the 1980's bears a strong resemblance to the organizations of certain other societies—e.g., to the family-dominated organizations of Italy and other parts of Europe, and even to a small number of such firms in our own country. There will be

many fewer middle managers, and most of those who remain are likely to be routine technicians rather than thinkers. This similarity will be superficial, of course, for the changes we forecast here will be generated from quite different origins.

What organizational and social problems are likely to come up as by-products of such changes? One can imagine major psychological problems arising from the depersonalization of relationships within management and the greater distance between people at different levels. Major resistances should be expected in the process of converting relatively autonomous and unprogramed middle-management jobs to highly routinized programs.

These problems may be of the same order as some of those that were influential in the development of American unions and in focusing middle management's interest on techniques for overcoming the hourly workers' resistance to change. This time it will be the top executive who is directly concerned, and the problems of resistance to change will occur among those middle managers who are programed out of their autonomy, perhaps out of their current status in the company, and possibly even out of their jobs.

On a broader social scale one can conceive of large problems outside the firm, that affect many institutions ancillary to industry. Thus:

What about education for management? How do we educate people for routinized middle-management jobs, especially if the path from those jobs up to top management gets much rockier?

To what extent do business schools stop training specialists and start training generalists to move directly into top management?

To what extent do schools start training new kinds of specialists?

What happens to the traditional apprentice system of training within managerial ranks?

What will happen to American class structure? Do we end up with a new kind of managerial elite? Will technical knowledge be the major criterion for membership?

Will technical knowledge become obsolete so fast that managers themselves will become obsolete within the time span of their industrial careers?

MIDDLE-MANAGEMENT CHANGES

Some jobs in industrial organizations are more programed than others. The job that has been subjected to micromotion analysis, for instance has been highly programed; rules about what is to be done, in what order, and by what processes, are all specified.

Characteristically, the jobs of today's hourly workers tend to be highly programed—an effect of Taylorism. Conversely, the jobs shown at the tops of organization charts are often largely unprogramed. They are

"think" jobs—hard to define and describe operationally. Jobs that appear in the big middle area of the organization chart tend to be programed in part, with some specific rules to be followed, but with varying amounts of room for judgment and autonomy. One major effect of information technology is likely to be intensive programing of many jobs now held by middle managers and the concomitant "deprograming" of others.

As organizations have proliferated in size and specialization, the problem of control and integration of supervisory and staff levels has become increasingly worrisome. The best answer until now has been participative management. But information technology promises better answers. It promises to eliminate the risk of less than adequate decisions arising from garbled communications, from misconceptions of goals, and from unsatisfactory measurement of partial contributions on the part of dozens of line and staff specialists.

Good illustrations of this programing process are not common in middle management, but they do exist, mostly on the production side of the business. For example, the programers have had some successes in displacing the judgment and experience of production schedulers (although the scheduler is still likely to be there to act out the routines) and in displacing the weekly scheduling meetings of production, sales, and supply people. Programs are also being worked out in increasing numbers to yield decisions about product mixes, warehousing, capital budgeting, and so forth.

PREDICTING THE IMPACT

We have noted that not all middle-management jobs will be affected alike by the new technology. What kinds of jobs will become more routinized, and what kinds less? What factors will make the difference?

The impact of change is likely to be determined by three criteria:

1. *Ease of measurement*—It is easier, at this stage, to apply the new techniques to jobs in and around production than in, say, labor relations, one reason being that quantitative measurement is easier in the former realms.
2. *Economic pressure*—Jobs that call for big money decisions will tend to get earlier investments in exploratory programing than others.
3. *The acceptability of programing by the present jobholder*—For some classes of jobs and of people, the advent of impersonal rules may offer protection or relief from frustration. We recently heard, for example, of efforts to program a maintenance foreman's decisions by providing rules for allocating priorities in maintenance and emergency repairs. The foreman supported this fully. He was a harried and much blamed man, and programing promised relief.

Such factors should accelerate the use of programing in certain areas. So should the great interest and activity in the new techniques now apparent in academic and research settings.

The number of mathematicians and economic analysts who are being taken into industry is impressive, as is the development within industry, often on the personal staffs of top management, of individuals or groups with new labels like "operations researchers," "organization analysts," or simply "special assistants for planning." These new people are a cue to the emergence of information technology. Just as programing the operations of hourly workers created the industrial engineer, so should information technology, as planning is withdrawn from middle levels, create new planners with new names at the top level.

So much for work becoming more routinized. At least two classes of middle jobs should move *upward* toward *de*programedness:

1. The programers themselves, the new information engineers, should move up. They should appear increasingly in staff roles close to the top.
2. We would also expect jobs in research and development to go in that direction, for innovation and creativity will become increasingly important to top management as the rate of obsolescence of things and of information increases. Application of new techniques to scanning and analyzing the business environment is bound to increase the range and number of possibilities for profitable production. Competition between firms should center more and more around their capacities to innovate.

Thus, in effect, we think that the horizontal slice of the current organization chart that we call middle management will break in two, with the larger portion shrinking and sinking into a more highly programed state and the smaller portion proliferating and rising to a level where more creative thinking is needed. There seem to be signs that such a split is already occurring. The growth of literature on the organization of research activities in industry is one indication. Many social scientists and industrial research managers, as well as some general managers, are worrying more and more about problems of creativity and authority in industrial research organizations. Even some highly conservative company presidents have been forced to break time-honored policies (such as the one relating salary and status to organizational rank) in dealing with their researchers.

INDIVIDUAL PROBLEMS

As the programing idea grows, some old human relations problems may be redefined. Redefinition will not necessarily solve the problems, but it may obviate some and give new priorities to others.

Thus, the issue of morale versus productivity that now worries us may pale as programing moves in. The morale of programed personnel may be of less central concern because less (or at least a different sort of) productivity will be demanded of them. The execution of controllable routine acts does not require great enthusiasm by the actors.

Another current issue may also take a new form: the debate about the social advantages or disadvantages of "conformity." The stereotype of the conforming junior executive, more interested in being well liked than in working, should become far less significant in a highly depersonalized highly programed, and more machine-like middle-management world. Of course, the pressures to conform will in one sense become more intense, for the individual will be required to stay within the limits of the routines that are set for him. But the constant behavioral pressure to be a "good guy," to get along, will have less reason for existence.

As for individualism, our suspicion is that the average middle manager will have to satisfy his personal needs and aspirations off the job, largely as we have forced the hourly worker to do. In this case, the Park Forest of the future may be an even more interesting phenomenon than it is now.

CHANGES AT THE TOP

If the new technology tends to split middle management—thin it, simplify it, program it, and separate a large part of it more rigorously from the top—what compensatory changes might one expect within the top group?

This is a much harder question to answer. We can guess that the top will focus even more intensively on "horizon" problems, on problems of innovation and change. We can forecast, too, that in dealing with such problems the top will continue for a while to fly by the seat of its pants, that it will remain largely unprogramed.

But even this is quite uncertain. Current research on the machine simulation of higher mental processes suggests that we will be able to program much of the top job before too many decades have passed. There is good authority for the prediction that within ten years a digital computer will be the world's chess champion and that another will discover and prove an important new mathematical theorem; and that in the somewhat more distant future "the way is open to deal scientifically with ill-structured problems—to make the computer coextensive with the human mind."[2]

Meanwhile, we expect top management to become more abstract, more search-and-research oriented and correspondingly less directly involved in the making of routine decisions. Allen Newell recently suggested to one of the authors that the wave of top-management game playing may be one manifestation of such change. Top management of the 1980's may

[2] See Herbert A. Simon and Allen Newell, "Heuristic Problem Solving: The Next Advance in Operations Research," *Operations Research,* January-February 1958, p. 9.

indeed spend a good deal of money and time playing games, trying to simulate its own behavior in hypothetical future environments.

ROOM FOR INNOVATORS

As the work of the middle manager is programed, the top manager should be freed more than ever from internal detail. But the top will not only be released to think; it will be *forced* to think. We doubt that many large companies in the 1980's will be able to survive for even a decade without major changes in product methods, or internal organization. The rate of obsolescence and the atmosphere of continuous change which now characterize industries like chemicals and pharmaceuticals should spread rapidly to other industries, pressuring them toward rapid technical and organizational change.

These ideas lead one to expect that researchers, or people like researchers, will sit closer to the top floor of American companies in large numbers; and that highly creative people will be more sought after and more highly valued than at present. But since researchers may be as interested in technical problems and professional affiliations as in progress up the organizational ladder, we might expect more impersonal, problem-oriented behavior at the top, with less emphasis on loyalty to the firm and more on relatively rational concern with solving difficult problems.

Again, top staff people may follow their problems from firm to firm much more closely than they do now, so that ideas about executive turnover and compensation may change along with ideas about tying people down with pension plans. Higher turnover at this level may prove advantageous to companies, for innovators can burn out fast. We may see more brain picking of the kind which is now supposedly characteristic of Madison Avenue. At this creating and innovating level, all the current work on organization and communication in research groups may find its payoff.

Besides innovators and creators, new top-management bodies will need programers who will focus on the internal organization itself. These will be the operations researchers, mathematical programers, computer experts, and the like. It is not clear where these kinds of people are being located on organization charts today, but our guess is that the programer will find a place close to the top. He will probably remain relatively free to innovate and to carry out his own applied research on what and how to program (although he may eventually settle into using some stable repertory of techniques as has the industrial engineer).

Innovators and programers will need to be supplemented by "committors." Committors are people who take on the role of approving or

vetoing decisions. They will commit the organization's resources to a particular course of action—the course chosen from some alternatives provided by innovators and programers. The current notion that managers ought to be "coordinators" should flower in the 1980's, but at the top rather than the middle; and the people to be coordinated will be top staff groups.

TIGHT LITTLE OLIGARCHY

We surmise that the "groupthink" which is frightening some people today will be a commonplace in top management of the future. For while the innovators and the programers may maintain or even increase their autonomy, and while the committor may be more independent than ever of lower-line levels, the interdependence of the top-staff oligarchy should increase with the increasing complexity of their tasks. The committor may be forced increasingly to have the top men operate as a committee, which would mean that the precise individual locus of decision may become even more obscure than it is today. The small-group psychologists, the researchers on creativity, the clinicians—all should find a surfeit of work at that level.

Our references to a small oligarchy at the top may be misleading. There is no reason to believe that the absolute numbers of creative research people or programers will shrink; if anything, the reverse will be true. It is the *head men* in these areas who will probably operate as a little oligarchy, with subgroups and sub-subgroups of researchers and programers reporting to them. But the optimal structural shape of these unprogramed groups will not necessarily be pyramidal. It is more likely to be shifting and somewhat amorphous, while the operating, programed portions of the structure ought to be more clearly pyramidal than ever.

The organization chart of the future may look something like a football balanced upon the point of a church bell. Within the football (the top staff organization), problems of coordination, individual autonomy, group decision making, and so on should arise more intensely than ever. We expect they will be dealt with quite independently of the bell portion of the company, with distinctly different methods of remuneration, control, and communication.

CHANGES IN PRACTICES

With the emergence of information technology, radical changes in certain administrative practices may also be expected. Without attempting to present the logic for the statements, we list a few changes that we foresee:

With the organization of management into corps (supervisors, programers, creators, committors), multiple entry points into the organization will become increasingly common.

Multiple sources of potential managers will develop, with training institutions outside the firm specializing along the lines of the new organizational structure.

Apprenticeship as a basis for training managers will be used less and less since movement up through the line will become increasingly unlikely.

Top-management training will be taken over increasingly by universities, with on-the-job training done through jobs like that of assistant to a senior executive.

Appraisal of higher management performance will be handled through some devices little used at present, such as evaluation by peers.

Appraisal of the new middle managers will become much more precise than present rating techniques make possible, with the development of new methods attaching specific values to input-output parameters.

Individual compensation for top staff groups will be more strongly influenced by market forces than ever before, given the increased mobility of all kinds of managers.

With the new organizational structure new kinds of compensation practices—such as team bonuses—will appear.

IMMEDIATE MEASURES

If the probability seems high that some of our predictions are correct, what can businessmen do to prepare for them? A number of steps are inexpensive and relatively easy. Managers can, for example, explore these areas:

1. They can locate and work up closer liaison with appropriate research organizations, academic and otherwise, just as many companies have profited from similar relationships in connection with the physical sciences.

2. They can re-examine their own organizations for lost information technologists. Many companies undoubtedly have such people, but not all of the top executives seem to know it.

3. They can make an early study and reassessment of some of the organizationally fuzzy groups in their own companies. Operations research departments, departments of organization, statistical analysis sections, perhaps even personnel departments, and other "odd-ball" staff groups often contain people whose knowledge and ideas in this realm have not been recognized. Such people provide a potential nucleus for serious major efforts to plan for the inroads of information technology.

Perhaps the biggest step managers need to take is an internal, psychological one. In view of the fact that information technology will challenge many long-established practices and doctrines, we will need to rethink some of the attitudes and values which we have taken for granted. In particular, we may have to reappraise our traditional notions about the worth of the individual as opposed to the organization, and about the mobility rights of young men on the make. This kind of inquiry may be painfully difficult, but will be increasingly necessary.

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